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BY

BERTRAM G. COOPER, A.F.AË.S.

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Notices of the Aëronautical Society of Great Britain.

Elections.

November: Major-General Niro Inouye (Associate Member).
G. H. Foley (Member).

January: W. Lockwood Marsh (Member—transfer from Associate Membership).
Oscar A. Danielson (Associate Member).

Wilbur Wright Memorial Lecture, 1915.

Professor G. H. Bryan, Sc.D., F.R.S., has accepted the invitation of the Council to deliver the above lecture. He has chosen for his subject, "The Rigid Dynamics of Circling Flight (Steady Motion in a Circle—Lateral Steering of Aeroplanes)." As at present arranged the lecture will be given at the Royal Society of Arts, John Street, Adelphi, on Thursday, 20th May, 1915, at 8.30 p.m. At the same time the presentation will be made to Professor Bryan of the Gold Medal awarded to him. Further details will be announced in due course.

Annual General Meeting.

Owing primarily to the war it has been thought desirable to postpone the Annual General Meeting of the Society, which should take place in March, until 20th May, 1915, immediately before the Wilbur Wright Lecture.

Northampton Polytechnic Institute, Prizes for Aeronautical Students.

The sum of £5 donated by the Society to the Northampton Polytechnic Institute has been awarded to their Aeronautical Students in the following manner by the Governing Body of the Institute:—

1st Prize, value £2, Herman Shaw.
2nd Prize, value £1, F. G. Hindsley and A. G. Humphreys (equal), 10s. each.
Essay Prize, value £2, H. Reiner.

It is understood that Mr. Reiner has not yet claimed his prize, which is still awaiting him.

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Technical Terms Committee.

On the initiative of the Comptroller-General of the Patent Office, the Council have appointed Mr. A. S. A. Ormsby as officially representing the Patent Office on the Technical Terms Committee.

Members' Subscriptions.

Members who have not yet paid their subscriptions for the current year are reminded that these became due on the 1st January.

Wilbur Wright Memorial Fund.

The following account shows the state of the Fund to the 31st December, 1914:—

Cr. 1914.

		£	s.	d.
Jan. 1.	Balance brought forward	43	14	7
Jan. 1.	Canada 4% Stock 1940-60 (G. Brewer and others) at cost	531	10	9
Apl. 2.	Dividend on £550 Canada 4% Stock	10	7	2
Apl. 25.	Subscription from Mr. George Thatcher and Mr. G. Robin Thatcher	3	3	0
June 27.	Interest on Aero Educational Premiums Fund deposit	3	14	6
Oct. 6.	Dividend on £550 Canada 4% Stock	10	6	3
Oct. 20.	Subscription by British Wright Co., Ltd.	50	0	0
Nov. 10.	Subscription from Mr. Cleveland R. Grace ...	5	0	0
Dec. 1.	Subscription from Mr. George Hann	10	10	0
Dec. 7.	Interest on Aero Educational Premiums Fund deposit	5	9	7
		673	15	10

Dr. 1914.

	Premium to Dr. R.T. Glazebrook for 2nd Wilbur Wright Memorial Lecture	21	0	0
	Total of Fund	652	15	10
	Investment as above	531	10	9
	Balance at Bank, 31st December, 1914	£121	5	1

Aero Educational Premiums Fund.

The following account shows the state of the Fund to the 31st December, 1914:—

Cr. 1914.

		£	s.	d.
Jan. 1.	On Deposit	400	18	6
May 21.	Subscription from Lord Northcliffe	100	0	0
Nov. 2.	Subscription from Mr. Frank McClean	87	10	0
	Total of Fund	588	8	6

Dr. 1914.

Dec. 7.	Investment £600 War Loan	566	11	7
	Balance at Bank, 31st December, 1914	£21	16	11

OBITUARY.

REGINALD JORDAN ALSTON.

We very much regret to announce the death of Mr. Reginald Alston, a Student of the Society, which he joined in January, 1913. Mr. Alston, who had previously been employed at Messrs. Vickers, was at the time of his death acting as chief designer to the Sopwith Aviation Company. In this capacity he was responsible for the seaplane in which he was flying as a passenger on 1st November, 1914, in Southampton Water, off Netley, when, owing probably to stalling, the machine nose-dived into the water. The pilot, Mr. Victor Mahl, was rescued, but Mr. Alston's body was only recovered later, being found still strapped in the sunken machine.

His youth—he was only in the early twenties—had not permitted Mr. Alston to develop the qualities of which he gave such early promise, but his loss is a severe blow to the country at the present juncture.

MAJOR ALFRED HERBERT TYLER, R.E.

Major Alfred Herbert Tyler, Royal Engineers, was born at Hampton Court in 1870, the eleventh in a family of twelve children of Sir H. W. Tyler, R.E., M.P., and grandson of General Sir C. W. Pasley, K.C.B., R.E. Educated at Cheltenham College (where he took a Scholarship) and the Royal Military Academy, Woolwich, he was commissioned in the Royal Engineers in 1890, promoted Lieutenant in 1893, Captain in 1901, and Major in 1910. He was employed on two Boundary Commissions and in the Karene Expedition in West Africa, in which he was wounded, and for which he received a medal with clasp. He served through the South African War, for which he received the Queen's medal with four clasps and the King's medal with two clasps. On his return home in 1907 he was employed in the Royal Arsenal till 1912, and then as Assistant to the Chief Engineer, Southern Command, at Salisbury. Among the first to sail for the German War, Major Tyler was employed on Lines of Communication for three months and then appointed to command the 5th Field Company, R.E., in the 2nd Division. He took up his new post on 10th November, and was killed in action leading his men at the charge ahead of the troops on either flank in the fierce fighting before Ypres of the 11th November, at 9.30 p.m.

Major Tyler had a most considerate, gentle nature, and the rare faculty of bringing out the good points in others in intercourse with him which endeared him to everyone, and he leaves a widow and three young boys bereaved of his loving care. He had for several years been a Member of the Aeronautical Society, but could not, on account of his duty, attend the meetings.

MAJOR RALEIGH, R.F.C.

By the death of Major G. H. Raleigh, Essex Regiment and Royal Flying Corps, the Army has lost a most valuable and distinguished officer and the Aeronautical Society a member who, by combining in a high degree a knowledge of military requirements and a personal fondness for practical aeronautical research, seemed to have before him a great future in assisting the progress of military aviation.

George Hebden Raleigh was born in Melbourne on June 20th, 1878, and received his commission in the Essex Regiment in 1899, being promoted to full Lieutenant the following year. With the 1st Battalion of the Essex Regiment he served under Sir John French in the Kimberley Relief Force, and afterwards in the famous march which brought General Cronje to bay at Paardeberg. The battalion was then with the late General Kelly-Kenny's 6th Division, and young

Mr. Raleigh was in the fighting at Poplar Grove and Driefontein. In the assault on the latter position he was dangerously wounded, but apparently made a quick recovery, for he was with his regiment again in the actions at Vet River and Zand River, and later on the march to Pretoria, being present in the fighting at Pretoria, Johannesburg, Diamond Hill and Belfast, which resulted in President Kruger's flight to Europe. His next actions were at Frederickstad, when General Barton's force was relieved, and at Colesburg. Afterwards he served with mounted infantry and came out of the war with the unusual distinction of possessing the Queen's South African medal with six clasps and the King's medal with two clasps.

He received his captaincy in 1908, and was again posted to the 1st Essex in Burma, afterwards serving on the North-West Frontier. About 1911 he came home to do duty with the 3rd Essex—the old Essex Rifles Militia—at Warley, and then began to take a keen interest in flying. He joined the Bristol School at Brooklands when that establishment was at its most brilliant period under the control of Mr. C. P. Pizey, now a Commander in the Greek Navy, and the late Mr. Harry Fleming, and he took his Aero Club Certificate, No. 196, there, the certificate being dated March 12th, 1912.

Later in that year he was appointed to the old Air Battalion, R.E., at Farnborough, and when the Royal Flying Corps was formed he commanded No. 4 Squadron, first at Farnborough and later at Netheravon. While there he did much experimental work of high value, especially in flying and landing at night. Frequently he made long flights far across Salisbury Plain in the dark, on one occasion at least going out round the City of Salisbury on a night when there was no moon, for he found that on a clear starlight night it was possible to distinguish the nature of the ground below, though when on ground level all appeared dark.

In June, 1914, in the King's Birthday Honours, Captain Raleigh was promoted to substantive Major by brevet, having previously held the rank of temporary Major, as a Squadron Commander, R.F.C.

No. 4 Squadron was one of the three which went to France in the middle of August, the 60 or 70 machines all crossing the Channel in the course of a few hours, starting at set intervals with machine-like regularity, one of the finest examples of organisation of the war, and certainly the best piece of combined work done by the Flying Services up to the present. Major Raleigh was responsible for much other good work done by his squadron during the war, and was mentioned in despatches by Sir John French in October.

His death occurred in one of those simple accidents which cost so many good lives in all spheres of activity. He had been out along the Belgian coast from Dunkirk on the morning of January 21st, on one of the fast little Sopwith biplanes, known in the R.F.C. as "tabloids." While returning over the sea close to Dunkirk his engine stopped, and he attempted a very long glide to reach the shore. So far as one can gather from those who were there shortly afterwards, he almost succeeded in reaching the sands, and in a last effort to do so stalled the machine, which, in the natural order of things, made a nose-dive to recover itself, and struck the sand through a foot or two of water before picking up sufficient speed to come under control again and to allow the pilot to get the nose up.

Major Raleigh was still alive when people near by ran to the wreck, but he had both legs broken and had sustained internal injuries from which he died in hospital shortly afterwards.

Despite his highly distinguished career in the Service, and his marked ability as an aviator, Major Raleigh was the most modest of men, and his quiet gentle manner gave no hint of his experiences of war, of which he had seen more than any except a very few men of his age. In him this country has lost a very gallant gentleman and he can ill be spared.

C. G. G.

XUM

THE DEATH OF THE LATE MR. E. T. BUSK AND THE POSTHUMOUS AWARD TO HIM OF THE GOLD MEDAL OF THE AERONAUTICAL SOCIETY.

In announcing, in the issue of July, 1914, the award of the Gold Medal of the Aëronautical Society of Great Britain to Prof. Bryan, it was remarked that his work had fortunately been appreciated in the quarters where time and money were available to turn it to practical use. Those who had followed the lecture by Mr. Bairstow (see the April JOURNAL, 1914, p. 84) and Dr. Glazebrook's Wilbur Wright Lecture (see the July JOURNAL, 1914, p. 294) were in a position to know that the quarters referred to were the Royal Aircraft Factory and the National Physical Laboratory, but only a few were in a position to know how much importance was to be attached to the work of the Mr. Busk mentioned by Mr. Bairstow and Dr. Glazebrook. When, at the Wilbur Wright Memorial Banquet, 1914, Colonel Seely had made the first public announcement of his flight on the stable aeroplane produced at the Royal Aircraft Factory, the pilot's name had been veiled in anonymity, and only a privileged few knew that he was in fact the designer of the R.E.1. Those who knew, however, felt quietly confident of future stability work in this country, with such collaborators as Mr. Busk and Mr. Bairstow at the beginning of their careers, and the shock of the former's tragic death was all the greater, therefore, when it became known that he had been burnt to death in the air on November 5th, 1914. Instead of being able to look forward to the further triumphs that would undoubtedly have been his, we can now only place on record our great appreciation of what our late distinguished member had already accomplished and our very deep regret at his loss.

It is not permissible at the present juncture to discuss his career and work except in the general terms employed in the following obituary notice, kindly supplied by Mr. Mervyn O'Gorman, C.B. (Superintendent of the Royal Aircraft Factory):—

Edward Teshmaker Busk, born March 8th, 1886, died November 5th, 1914, was educated at Harrow and Cambridge. A Scholar of King's College, Cambridge, he secured First Class Honours in the Mechanical Sciences Tripos, obtained the John Wimbourne Prize, etc. He distinguished himself early as an engineer during the years he worked at Messrs. Halls and Co., of Dartford.

He joined the staff of the Royal Aircraft Factory as Assistant Engineer in Charge of Physical Experimental work on June 10th, 1912. There he devoted much of his time to the mathematics and dynamics of stable flight on the full size, as distinct from the model, aeroplane. He introduced many valuable improvements, of which it is not permissible to give particulars at the present juncture, his work not being confined to the solution of aeroplane stability, but covering a wide and varied range. His valuable researches into the nature and cause of wind gusts and his work in connection with the offensive and defensive uses of aircraft in warfare may be specially mentioned. He also guided his branch in the production of aeroplane instruments, some of which were exhibited at the Royal Society in May and June, 1913, by permission of the Superintendent, Royal Aircraft Factory.*

* Members present at Mr. O'Gorman's lecture to the Aëronautical Society on January 27th, 1913 (AERONAUTICAL JOURNAL, April, 1913, pp. 59-82), will remember Mr. Busk's introduction as the designer of the "ripometer," then first publicly exhibited, and his contributions to our discussions were always interesting and valuable.—[ED.]

By the autumn of 1913 he had carried his researches so far that complete stability without material loss of efficiency could be obtained for any aeroplane designed in accordance with his results. In November, 1913, he was able to make flights of several hours' duration in winds up to 38 miles per hour, without at any time using any balancing, controlling, or steering mechanism whatever, save for alighting purposes. He took Colonel Seely on such an uncontrolled flight, and later on made demonstration flights before their Majesties the King and Queen. The matter was introduced in practical form to the Royal Flying Corps by his taking the Commanding Officer, Colonel Sykes, as passenger, from the Royal Aircraft Factory, Farnborough, to Salisbury Plain and back, while both passenger and flyer, being freed from the use of controls, wrote notes and observations continuously throughout the journey. This trial was repeated by Colonel Brancker as pilot as well as many other officers.

He was flying his own stable aeroplane at the time of its destruction by fire in the air, at Aldershot, at a height of some 800 feet.

So far as it has been possible to reconstruct the accident, the fire is ascribed to a spark igniting the petrol vapour, but the exact cause cannot well be traced owing to the complete destruction of the machine.

Mr. Busk's scientific attainments and versatility were shown by the variety of matters entrusted to him by the Superintendent of the Royal Aircraft Factory. These included the general control of the chemical, metallurgical and physical research and test work at the Factory.

His loss is deeply deplored at Farnborough, as much because of his cheery and charming personality as because of the gallant manner in which he faced every kind of risk in the verification of the mathematical theories he had himself worked out or inspired.

He resembled other men of genius in the simplicity of his methods and the speed at which he worked, and he was remarkable for the soundness of the scientific judgments he arrived at. His youth, for he was only 28 years of age, is an added cause for regretting the termination of a career so brilliantly commenced.

He was buried, with military honours, in the Military Cemetery, Aldershot, on Monday, 9th November, 1914. The Society sent a wreath and was officially represented by the Secretary. Amongst the large number of naval and military officers and men who were present was a detachment of the London Electrical Engineers, of which body Mr. Busk was a Second Lieutenant.

At a meeting of the Council of the Society, held on the 18th November last, it was unanimously decided to award to Mr. Busk the Gold Medal of the Aëronautical Society of Great Britain, in recognition of his distinguished services to Aeronautical Science. The medal will be presented to Mrs. Busk on her son's behalf at a date to be subsequently fixed.

On the death of Mr. Busk a movement was immediately initiated at the Royal Aircraft Factory to found a Memorial. From this two schemes have arisen, due respectively to Mr. Mervyn O'Gorman, C.B., and to Sir Edward Busk, as representing Mrs. Busk and other members of the family. The former scheme provides for an Edward Busk Lecture, the latter for an Edward Busk Studentship. Full details will be announced later.

THE RESISTANCE OF INCLINED STRUTS IN A UNIFORM AIR CURRENT.

BY A. P. THURSTON, D.SC., A.F.AË.S., AND N. TONNSTEIN, B.SC., A.F.AË.S.

Description of the Struts.

These experiments were carried out in the aerodynamical laboratory at East London College, with a view to investigating the variation of air resistance of certain bars as the inclination of their longitudinal axes to the direction of the wind was varied, the current of air being kept at a constant velocity. Four bars were used, having the cross sections shown in Fig. 1, that is, a square, a 2:1

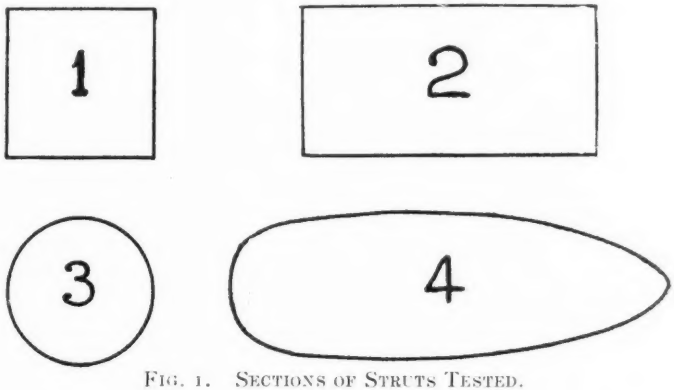
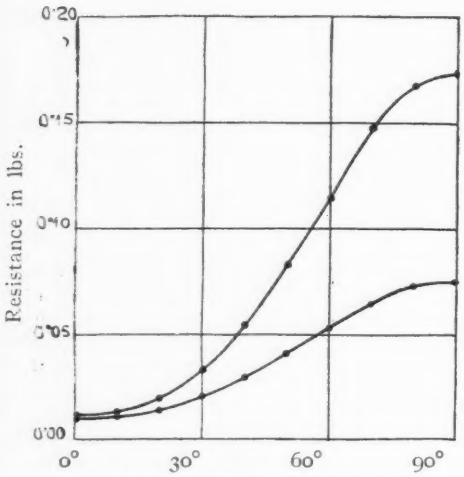


FIG. 1. SECTIONS OF STRUTS TESTED.

rectangle, a circle, and a 3:1 streamline form. The bars were carefully made in wood to an equal length of 34in. and approximately a maximum width of 1in. in each case. It was thought that interference due to the ends of the bars would be minimised by having some sort of entering edge fitted to the flats. Accordingly, wedge-shaped ends were tried in the case of a fifth bar, but various difficulties seemed to lead to erroneous results and they were abandoned in favour of squared-off ends.

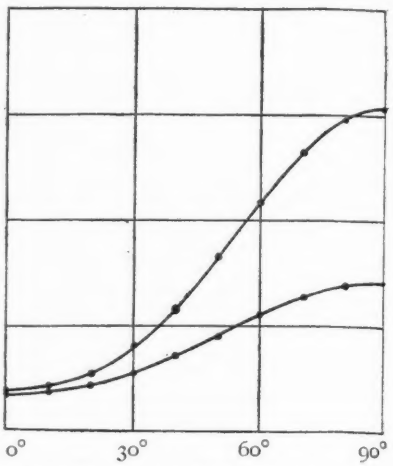
Mounting of the Struts.

The strut to be tested was mounted on the balance by means of a screwed rod, passing through it centrally and at right angles to its length. The inclination of the longitudinal axis of the strut to the direction of the wind was varied by increments of 10° from 0°, *i.e.*, parallel to the air current, to 90°, *i.e.*, perpendicular to it. To ensure symmetry, the strut was swung in all directions, and the resistance was measured in each position. One of the authors has shown in a previous paper that the resistance of the end portions of a bar is less than that of portions of equal length in the centre, owing to the slipping away of the air at the ends of the specimen. By subtracting the resistance of a shortened bar from



INCLINATION OF BAR TO WIND IN DEGREES.

FIG. 2. NO. 1 (SQUARE).

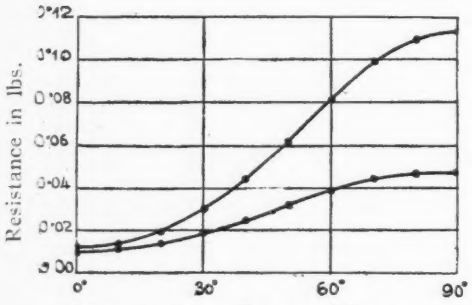


INCLINATION OF BAR TO WIND IN DEGREES.

FIG. 3. NO. 2 (RECTANGLE).

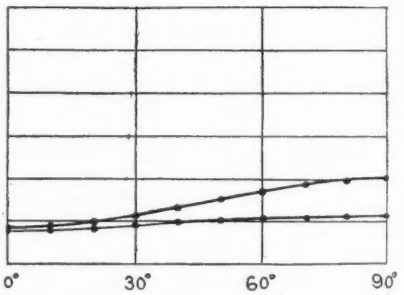
Upper curves refer to bars 34″ long.
Lower curves refer to shortened bars 16″ long.

the readings obtained with the bar at a greater length, end effects are to some extent eliminated and the remainder gives, to a fair degree of accuracy, the resistance of a certain portion cut from a bar of infinite length. The strut therefore, after being tested at its original length of 34in., was shortened to 16in. by having a length of 9in. cut off each end, and the experiment was repeated.



INCLINATION OF BARS TO WIND.

FIG. 4. NO. 3 (CIRCLE).



INCLINATION OF BARS TO WIND.

FIG. 5. NO. 4 (STREAMLINE).

Upper curves refer to bars 34″ long.
Lower curves refer to bars 16″ long.

The Tabulated Results.

Referring to the curves, Figs. 2, 3, 4 and 5 give the actual variation of resistance for each strut both before and after shortening. The readings from

which these curves have been plotted have not been tabulated as they are very numerous, the points shown on the curves being average values. Fig. 6 has been plotted from Table I., in which are tabulated the results obtained by

TABLE I.

Actual resistances in lbs. for a length of 18in. of bar.

Inclination of Bar to Wind.	No. 1. (Square).	No. 2. (Rectangle).	No. 3. (Circle).	No. 4. (Streamline).
90°	.0987	.0829	.0664	.0180
80°	.0942	.0771	.0631	.0169
70°	.0833	.0689	.0551	.0157
60°	.0605	.0510	.0442	.0126
50°	.0425	.0384	.0303	.0099
40°	.0244	.0204	.0197	.0061
30°	.0140	.0126	.0101	.0040
20°	.0056	.0054	.0048	.0025
10°	.0027	.0035	.0020	.0023
0°	.0024	.0021	.0020	.0017

subtracting the resistance of the shortened struts from that of the struts of original length, thus giving the resistance of 18in. length of strut shielded from

TABLE II.

Percentage of normal resistance.

Inclination of Bar to Wind.	No. 1. (Square).	No. 2. (Rectangle).	No. 3. (Circle).	No. 4. (Streamline).
90°	100	100	100	100
80°	96	95	94.8	96.1
70°	84.5	81.5	82.7	85.5
60°	64	62.7	66	77
50°	42	43.1	46.6	54
40°	25.4	26.1	29	34.5
30°	14.2	14.5	15.3	22.8
20°	6.1	6.1	7.2	15
10°				
0°				

end effects. Table II. gives the percentage resistance of the struts at all angles in terms of their resistance when normal. Table III. shows this percentage

TABLE III.

Percentage of normal resistance as corrected for constant projected length.

Inclination of Bar to Wind.	No. 1. (Square).	No. 2. (Rectangle).	No. 3. (Circle).	No. 4. (Streamline).
90°	100	100	100	100
80°	97.5	96.5	96.3	97.6
70°	89.9	86.7	88	91
60°	73.9	72.3	76.2	82.8
50°	54.8	56.2	60.8	70.4
40°	39.5	40.6	45	53.6
30°	28.4	29	30.6	45.6
20°	17.8	18	21.1	43.9
10°				
0°				

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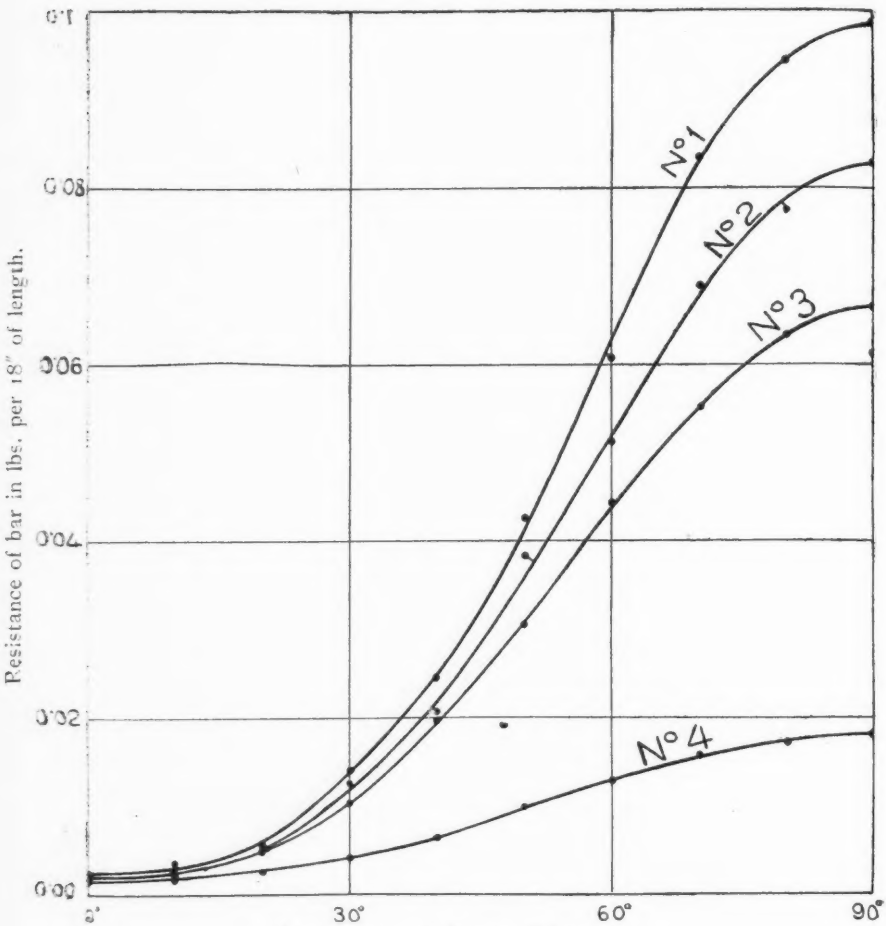
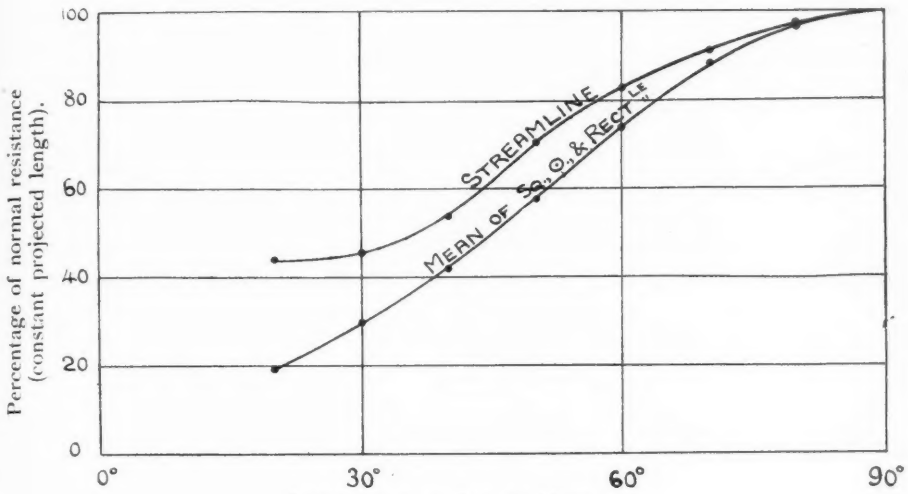


Fig. 6.

increased on the supposition that the projected length of the bar perpendicular to the wind remains constant. In both Tables II. and III. the values of the resistance have been read off from the smooth curves of Fig. 6. It will be noticed that the first three columns of Table III. give values of the same order. Also, if experimental discrepancies are removed by the drawing of smooth curves, the square, circle and rectangle can be brought into still closer agreement. These considerations have led to the plotting of the mean curve of Fig. 7, but it is to be noted, however, that curves representing columns Nos. 1, 2 and 3 of Table III. differ somewhat in shape. The streamline section is distinct from these three as shown in Fig. 7.

Some Comparisons with Non-inclined Struts.

It is possible to make some interesting comparisons between the resistance of inclined struts and of struts placed normal to the wind, but having a cross



INCLINATION OF BAR TO WIND.

FIG. 7.

section equal to the section of the inclined struts in the direction of the wind. The wind velocity used in the above experiments was between 12 and 13 m.p.h. It was maintained constant for each experiment, but no great care was taken to keep it strictly the same for different struts and consequently the results are not comparable among themselves. For the purposes of the above comparison, therefore, it is proposed to use the values of the resistances of bars of various sections as given by one of the authors in a previous paper,* and to assume that the variation of resistance due to inclination, as given in Table III., is the same for the higher velocities at which these coefficients were determined.

In the paper referred to the constant of the section, K, is given as follows:—

For a circle	...	K = .0027
,, square	...	K = .00441
,, 2 : 1 rectangle	...	K = .0032
,, 4 : 1 rectangle	...	K = .00254
,, 2 : 1 ellipse ...	...	K = .00177

From Table III., the resistance of a bar of circular section at 30° is 0.306 of the resistance of the normal bar of equal projected length. At this angle the cylinder has a section in the direction of the wind equal to an ellipse whose major axis is twice the length of its minor axis. Using the values of K for the sections, the inclined cylinder is $\frac{.306 \times .0027}{.00177}$ or 46.7% of the normal bar of equivalent section in resistance. Similarly the bars of square and rectangular section, when inclined at 30°, have resistances of 39.1% and 36.6% respectively of that of the normal bars of equivalent cross section. Lack of data prevents this examination being carried further at present.

This advantage of the inclined bar was suggested in the report of the National

* AERONAUTICAL JOURNAL, April, 1912.

Physical Laboratory, 1911-12. The value there given for a cylinder inclined at 30° is 0.28 of the normal resistance (for equal projected length). This differs from the value 0.306 given in Table III. for the cylinder, but agrees more closely with the mean of the cylinder, and square and rectangular prisms, *i.e.*, 0.29.

Conclusions to be Drawn.

Briefly, the results of these experiments show that there is considerable aerodynamic advantage in inclining the struts of a flying machine, but that due to the asymptotic character of the curves this is not marked for small inclinations. The gain is less in the case of long streamline forms.

In conclusion the authors desire to thank Mr. C. H. Powell, B.Sc., for help in preparing the apparatus.

FLAPPING FLIGHT.

(WITH A NOTE ON HELICOPTERS).

BY MAURICE F. FITZGERALD, D.SC., A.M.I.C.E., M.I.M.E.

A paper on "Flapping Flight of Aeroplanes" by the present writer was communicated by the late Professor G. F. FitzGerald to the "Proceedings" of the Royal Society (Vol. 64, pp. 420-430) in 1899. At that date much that is now almost common knowledge concerning the mechanics of flight was little thought of, much less understood, practical aviation did not exist, and a limited supply of experimental results presented confusing specimens of discordant and unreliable data to the inquirer. The development, during the last eight years, of the practice and science of aviation, seems to justify a review of the paper of 1899 in the light of better information, and of a better understanding of the influence of head resistance and other things, ignored fifteen years ago.

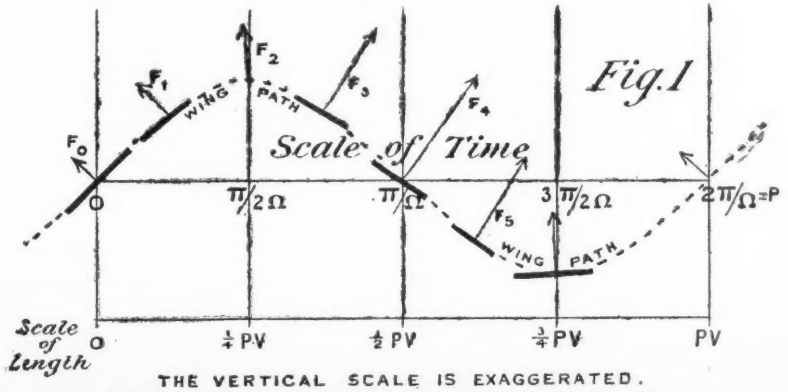
In the first part of the present paper, the matter is treated much on the same lines as before, except that head resistance is not considered negligible, and a comparison is made of the efficiency of wing propulsion, compared with screw propulsion, showing that the former is at least as efficient as the latter. In the second part the influence of wing section, and consequent alteration of the relations of lift to drag, is discussed, with the result that no material alteration of the general conclusions previously drawn in favour of the wing appears probable.

The units employed are, unless otherwise stated, feet, seconds, and the weight of one pound. Angles are taken in circular measure.

PART I.

The wings as flat planes, moved up and down, and feathered.

The total weight of the machine, wings included, is taken to be one pound's weight. Wings are taken to be thin planes, moved vertically up and down by an engine in the body they carry, and caused, by mechanism, to make a small varying angle with the path of their centres in the air, in such a way that during the up-stroke they pass nearly edgewise through the air as shown in Fig. 1, and



THE VERTICAL SCALE IS EXAGGERATED.

PRESSURES ON THE WING ARE INDICATED BY ARROWS F₀, F₁, &c

during the down-stroke are inclined downwards forward, but less inclined than their path, so that the pressure on them has a forward component, to supply propulsive force. The machine as a whole is taken to advance in a level line at a uniform velocity. This cannot be exactly true when there is only one wing, or pair of wings, but Lord Rayleigh pointed out, in some remarks, whose value must be herein gratefully acknowledged, on the previous paper, in a lecture at Manchester, that the condition could be satisfied as nearly as might be desired, by several wings moving like the pistons of a multi-crank engine to neutralise irregularities.

The principal symbols are :—

V = the uniform horizontal velocity, in feet per second.

S = area of wing in square feet per pound carried.

θ = small varying angle the plane makes with its path.

y = C sin Ωt = the height, above its mean level, of the wing's centre at time t, C and Ω being arbitrary constants.

ϕ = the angle the wing's path makes at any instant with the horizontal.

X and Y are respectively the horizontal and vertical components of the air pressure on the wing.

κ and μ are empirical constants, such that $\kappa SV^2\theta$ is the resultant force normal to the wing exerted by the air, and $\mu\kappa SV^2$ is the whole frictional and head resistance of the machine, wing surface included. The angles θ and ϕ are assumed to be small enough at all times for their sines and tangents to be sensibly the same as their circular measures, and cosines to be unity.

$\theta = a - b \cos \Omega t$ where a and b are small constants.

$\phi = \frac{C\Omega}{V} \cos \Omega t$, being $\frac{1}{V} \frac{dy}{dt}$.

Other assumptions might be made concerning the *modus operandi* of the wings, and in hovering, as of a kite, or of a humming bird in front of a flower, or of a sparrow seeking a perch in an ivy-covered wall, the wing action must be quite different from that above described. Some remarks on this matter are reserved for the conclusion of Part II.

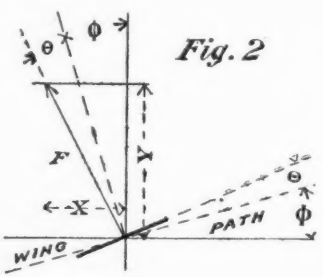


Fig. 2

From Fig. 2 representing a section of the plane at a point on its path—

$Y = \kappa SV^2\theta \cos(\phi + \theta) = \kappa SV^2\theta (1 - \theta\phi)$, in which the product $\theta\phi$ may be neglected as of second order of small numbers compared to 1.

$X = -\kappa SV^2 \left\{ \theta (\theta + \phi) + \mu \right\} = -\kappa SV^2 \left\{ \theta^2 + \theta\phi + \mu \right\}$, in which no term can be neglected, and μ must, as will shortly appear, be of the order of θ^2 in small numbers.

The whole impulse of Y upwards during a complete period $P = \frac{2\pi}{\Omega}$ from $t = O$, must equal that of the load of one pound downwards during the same period. That is

$$\int_0^P Y \, dt = P \qquad (a)$$

Similarly as the total head resistance is included in X

$$\int_0^P X \, dt = O \qquad (b)$$

Periodic terms will vanish in the integration and these equations reduce, on putting in the proper expressions for θ and ϕ to

$$\kappa SV^2 a = 1 \qquad (I.)$$

and

$$a^2 + \frac{b^2}{2} - \frac{b}{2}\frac{C\Omega}{V} + \mu = O \qquad (II.)$$

The work is done by an engine, which moves the wing vertically relatively to the body; let its work be measured in foot pounds per second per pound carried and denoted by E, then average rate of working $E = -\frac{1}{P}\int_0^P Y \frac{dy}{dt} \, dt$, wherein the minus sign is used because the force Y and the vertical velocity dy/dt must be in opposite directions when the engine is expending work.

This gives on integration—

$$E = \kappa SV^2 \frac{b}{2} C\Omega \qquad (III.)$$

Equation (I.) shows that the mean angle of incidence is the same, sensibly, as if the wing plane were fitted to an aeroplane and propelled in the ordinary way, in which case the propeller thrust would be $\kappa SV^2 (a^2 + \mu)$ and the useful work done would be V times this,

that is, $\eta E = \kappa SV^3 (a^2 + \mu)$

where E is the brake-power, and η the efficiency of the propeller.

By (II.)

$$a^2 + \mu = \frac{b}{2}\left(\frac{C\Omega}{V} - b\right)$$

and consequently

$$\eta E = \kappa SV^3 \frac{b}{2}\left(\frac{C\Omega}{V} - b\right)$$

and dividing this by (III.)

$$\eta = 1 - b\frac{V}{C\Omega} \qquad (IV.)$$

is the efficiency of wing propulsion, compared with direct thrust. The values of b and $C\Omega$ must, V being supposed given, be chosen so as to agree with the equations (I.), (II.), and with the hypothesis that $C\Omega/V$ is fairly small, and that b and a are small also. Hence $V/C\Omega$ is not small, being the reciprocal of $C\Omega/V$. To fix ideas, let $C\Omega/V = 1/3$, then $V/C\Omega = 3$, and choose $b = 1/16$. This will make $\eta = 81\frac{1}{4}\%$ which is as good as a good screw. From (II.) it will be found that $a^2 + \mu = 1/118$. At the speed of least power $\mu = a^2/3$ and $a = 1/12.6$ very nearly, that is close on 4° 33′ and $b = 1/16$ is 3° 35′ nearly. κ may be about $1/200$ and from (I.) $SV^2 = 2{,}520$. Any pair of values of S and V satisfying this will give the velocity and wing area per pound carried,

provided the whole can be so designed as to keep the head resistance down to the required amount. By (I.) $\kappa SV^2 = 1/a$ in (III.) so that

$$E = \frac{b}{2a} C\Omega \qquad (V.)$$

These give a loading of 3 ounces per square foot at 15 miles per hour; 12 ounces at 30 miles per hour; and 3 pounds at 60 miles per hour, with the assumed value of κ, when those are the economical speeds. The foot-pounds per second per pound carried run from 2.9 at the lowest to 11.6 at the highest speed. An active man can perhaps work at the former rate per pound of his own weight for a short time in running up stairs, and in rowing. At speeds like seven or eight miles an hour, and less, the loading is so light that wings are only structurally possible on the scale of small birds and of insects.

PART II.

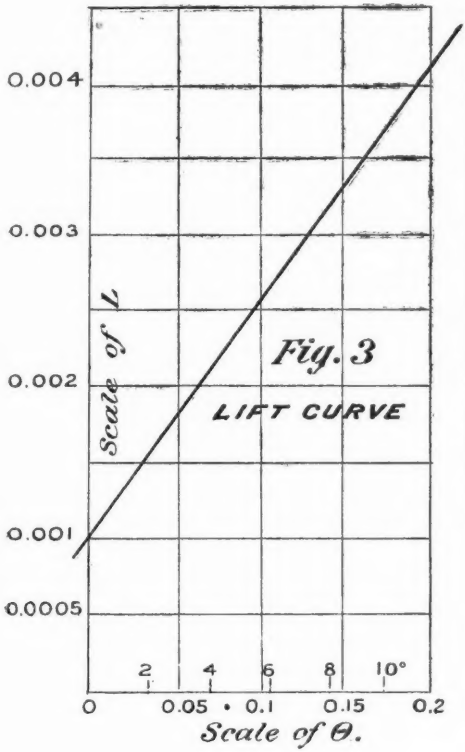
The Wings as cambered aerofoils, and other refinements of the theory.

There are several objections to including in μ the surface friction and eddy resistance of the wings themselves and it is therefore advisable to rearrange matters so that μ shall include only the head resistance of the body, as this seems to be fairly well represented, for ordinary purposes, by that of a flat surface of determined area, normal to wind. The case of curved wing sections introduces another disturbing element, owing to the direction of the resultant pressure not being at right angles to the chord, especially at small angles of incidence, where deviations, comparable with such average angles of incidence as are here considered, may occur. It is also desirable to take closer account of the difference between the cosine of the slope of the path and unity, than has been done above. It is not proposed to discuss the mass of experimental work now available in detail, with a view to establishing any definite theory. In any real case the indicator diagram of the motive power should be theoretically taken account of, whether the engine be of muscle or of metal, but, given the wing-path and some other data, it is theoretically possible to assign an indicator diagram that will fit. It is therefore legitimate to use formulæ which express assigned effects similar to those of known causes in phase and magnitude, without making too meticulous inquiry into their precise relations to pure mechanics.

Figs. 3 and 4 give the characteristics of the kind of lift curve, and of the curve of deviation of the resultant from normal to the chord, respectively, found with curved wing surfaces of good form. The figures are not precise copies of any one example such as might be taken from Eiffel, or from other sources, they only represent a kind of average curve of ordinary proportions, and of no special merits, capable of enabling a judgment to be made in this case between the flapping wing, and the propelled aeroplane, as regards aerodynamic efficiency.

It is obvious from the figures that the lift, within the range of angles of incidence considered, can be fairly represented by a constant added to the chord angle. The deviation from normal to the chord can be represented by a quadratic function of the chord angle, sufficiently well to show what the principal effects will be.

In Fig. 5 the force normal to the path is L and that parallel to the path is D. X and Y are as before. The velocity of the wing along its path is assumed to be uniform; but a correction for this can be made if desired, later on. The number $C\Omega/2V$ occurs so frequently that it is convenient to put $\lambda = C\Omega/2V$ for brevity, and it will be assumed that the slope angle ϕ of the wing-path does


0.004
0.003
0.002
0.001
0.0005
Scale of L
Fig. 3
LIFT CURVE
2
4
6
8
10°
0
0.05
0.1
0.15
0.2
Scale of Θ.

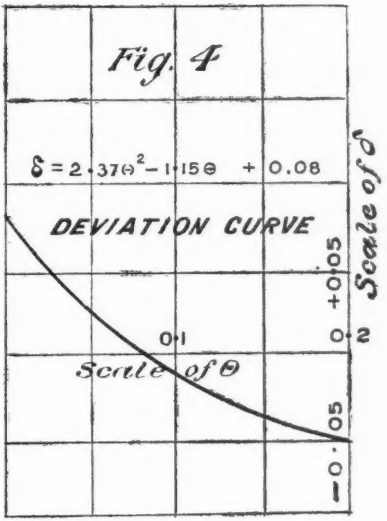


Fig. 4
δ = 2·37Θ² − 1·15Θ + 0.08
DEVIATION CURVE
0·1
Scale of Θ
+0·05
0
−0·05
Scale of δ

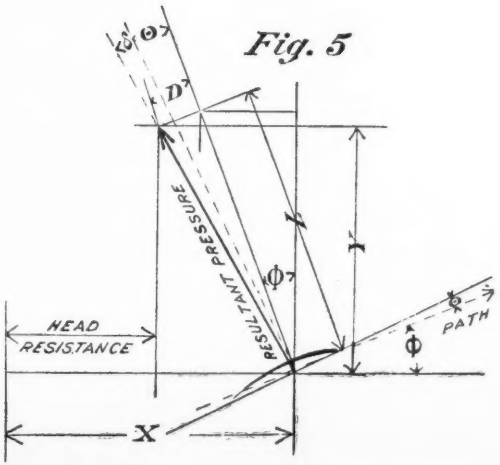


Fig. 5
R'(Θ)
D'
RESULTANT PRESSURE
L
Y
Φ
HEAD RESISTANCE
PATH
X

not anywhere exceed 45°. As V is the velocity along the wing-path, $\sin \phi = 2\lambda \cos \Omega t$ and when $t = 0$, $\lambda = 0.353$, as $\tan \phi < 1$, at most, and $\lambda^2 = 0.125$ at most, so that the latter is of the same order as probable values of a or b, at most. As precise fixing of V depends on the indicator diagram and mechanism, among other things, it is not unreasonable to assume that a constant value of V could be actually very nearly attained. The body is supposed to move horizontally at the average rate due to V constant along the wing-path. Within the range of values of λ considered it is a sufficiently good approximation to take $\cos \phi = (1 - \lambda^2) - \lambda^2 \cos 2\Omega t$, and dispense with elliptic functions. From Fig. 5 it is seen that

$$Y = L \cos \phi - D \sin \phi$$
$$X = -[L \sin \phi + D \cos \phi + \mu \kappa S V^2 \cos^2 \phi]$$

and the expressions assumed for L and D are

$$L = \kappa S V^2 (\theta + m); \; D = \kappa S V^2 (\theta + m)(\theta + \delta)$$

with

$$\theta = a - b \cos \Omega t; \; \delta = p\theta^2 + q\theta + r$$

in which a and b are arbitrary, provided they be small, but m, p, q and r are empirical constants depending on the pattern of wing. For example, Eiffel tested a section with flat underside and circular arc of rise 1/13.5 for back, which is suited fairly well by $m = 0.065$; $p = 2.37$; $q = -1.15$; $r = 0.08$ over a range from $\theta = 0$ to $\theta = 0.174$ (about 10°) and has $\delta = 0$ about the middle of this range; so that such figures as these may be taken to represent the general character of fairly good wing sections.

The detail of working out the full expressions for Y, X, etc., need not be given. The terms L and D are to be reduced to the forms

$$L = L_0 + L_1 \cos \Omega t + L_2 \cos 2\Omega t + \ldots$$
$$D = D_0 + D_1 \cos \Omega t + D_2 \cos 2\Omega t + \ldots$$

where L_0, L_1, etc., are functions of a, b, and the physical constants. These being multiplied by $\cos \phi$ and $\sin \phi$ according to (VI.) or (VII.) and averages taken as in Part I.

$$\frac{1}{P}\int_0^P Y dt = 1 = \kappa S V^2 [(a + m)(1 - \lambda^2) + \lambda D_1] \qquad \text{(VIII.)}$$

$$\frac{1}{P}\int_0^P X dt = O = (a + m)(a + \Delta)(1 - \lambda^2) + \frac{b^2}{2}(1 - \frac{3}{2}\lambda^2) Q - b\lambda + \mu (1 - 2\lambda^2) \qquad \text{(IX.)}$$

wherein

$$D_1 = -b \{3pa^2 + 2a(mp + q + 1) + r + m(1 + q)\}$$
$$Q = 1 + q + p(3a + m)$$
$$\Delta = pa^2 + qa + r$$

being the deviation from normal of the resultant for the mean angle of incidence a. If λ^2 be neglected as small, and $m = p = q = r = 0$, as in Part I. these reduce to (I.) and (II.). Also, if the rate of working be found in the same way as before

$$E = \kappa S V^3 [b\lambda (1 - \frac{3}{2}\lambda^2) + 2\lambda^2 D_0 + \lambda^2 D_2]$$

and if the tow-rope rate of working to be compared with this be taken to be

$$T = \kappa S V^3 [(a + m)(a + \Delta) + \mu]$$

and for μ, the value of μ given by (IX.) be substituted then on reducing, the efficiency is found to be

$$\eta = \frac{T}{E} = \frac{1}{1 - 2\lambda^2}\left[\frac{b\lambda - \frac{b^2}{2}(1 - \frac{3}{2}\lambda^2) + \lambda^2 (a + m)(a + \Delta)}{b\lambda (1 - \frac{3}{2}\lambda^2) + \frac{3}{2}b^2\lambda^2 \left\{p (2a + m) + q + 1\right\} + 2\lambda^2 (a + m)(a + \Delta)}\right]$$

and, if λ^2 be considered equivalent to zero, as in Part I., this reduces to the value given in Part I. Such plausible values of m, p, q and r as are above suggested make it appear that the efficiency is at least as great as estimated in Part I. In reality, however, the load should be the same when the wing is towed as a simple aeroplane as when flapping, and the mean speed should be V $(1 - \lambda^2)$ approximately. This enables V^2 to be eliminated by (VIII.) and finds a particular value of λ, at which this condition is satisfied, so that the value of η above given is not really accurate in general, but merely confirms the general correctness of Part I. Since q is negative and greater than unity in practical wing sections, the last two terms in the denominator may be negligible, being a difference of two small numbers of third order.

In these expressions, further modifications might be made, for example by assuming that the velocity of the wing along its path has a small simple harmonic disturbance, expressed by using V $\left\{1 - h \sin a (\Omega t - \epsilon)\right\}$ in place of V where ϵ is an angle of lag, and h is small. The principal terms above found are however then altered only by second order multiples of themselves, and as these would in any case be of the size affected by such things as the indicator diagram of the engine, and by details of its mechanism, it appears unnecessary to pursue the matter further.

Sculling Actions—that is, horizontal motion back and forwards, with reversal of the angle of incidence at each end of the stroke, provide support without involving any advance of the machine as a whole, though when there is only one pair of wings there is, of course, a small horizontal oscillation and there would usually be also a small vertical one as well, whereby the inertia of the machine provides the reaction against the varying forces. In other respects the action between the air and the machine is much the same as in simple progressive flight. The stresses due to inertia developed at the reversals of the motion in the wings and mechanism would be much larger than those in flapping flight, and preclude the use of this method except on a small scale, as for example by insects.

Feathering Paddle Wheels.

Paddle-wheels with nearly tangential-feathering floats, for instance those patented and experimented on by Mr. Clarkson and previous experimenters, are a sort of modification of sculling, in theory, but possess the property that the resultant pull can be made to alter its direction all round the axis by merely shifting the centre of the feathering eccentric without reversing the engine, so that the same paddle-wheel can be used for direct lift, for propulsion and as a brake, at will.

The present writer thought the paddle-wheel worth investigating in a preliminary way some years ago, on the lines of this paper, and the results are interesting and may be of use to any one who thinks about or makes experiments on paddle-wheels either as lifters or propellers.

XIIM

Fig. 6

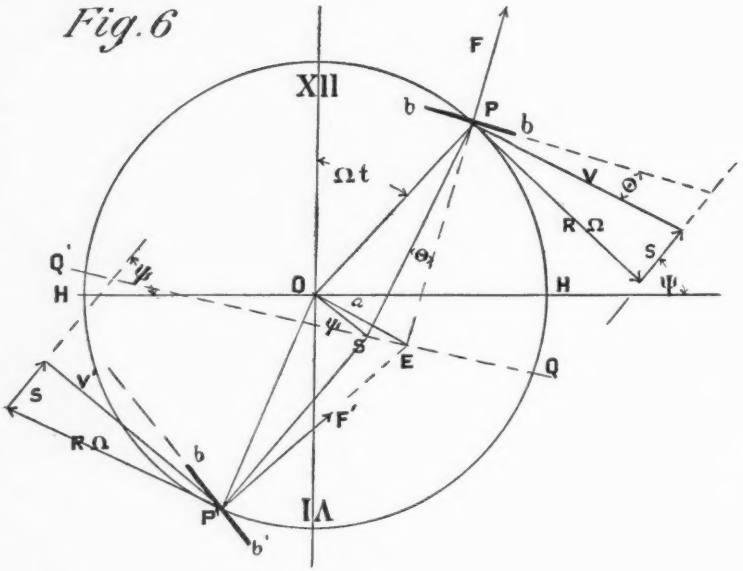


Fig. 6 represents, in a diagrammatic way, the essential features of the paddle-wheel. Two positions of a float, bb and b′b′, at two points P and P′ round the clock-face of its circle of revolution, are shown. The triangles of relative velocity are drawn at each point, with RΩ as tangential velocity; S inclined at ψ to horizontal, as direction and magnitude of the motion of the machine as a whole, and E the centre of the feathering eccentric, connected to the blade (which is pivoted at P to the radius) by a rod PE at right angles to the blade surface. V and V′ are the resultant relative velocities of the blade and still air, and θ the angle of incidence. Since the radius OP, and the rod PE are at right angles to the tangent to the circle at P, and to the blade respectively, a proper choice of scale for velocities enables the triangle POS to be used as that of velocities, by drawing OS at right angles to the bodily travel of the machine on whatever scale the radius R represents the tangential velocity. The calculation of the mean force may be made analytically, or else graphically, by finding the resultant pressure F from scaling V and the angle θ at a number of points round the circumference and forming the force polygon. If P be suitably placed in the blade, supposed of good aeroplane aspect, the forces F all pass through E, nearly, and consequently so does their resultant. There are two points QQ′ on the chord joining ES where θ vanishes, because at them PE and PS coincide, and F vanishes also. With moderate eccentricity, and a tangential speed RΩ four or five times the speed of advance S, as in aerial screw propellers, the resultant is practically at right angles to QQ′, by which therefore its direction is governed, and is easily found for any position of E. The resultant must, if the engine be doing work, oppose the rotation and this settles which way it points, when QQ′ is known.

The paddle follows the rule of the screw in requiring large wheels, few revolutions per minute, and small speed of advance for economy of power in direct lifting. However, if used as a propeller, with E vertically, or nearly so, below the centre, a machine fitted with ordinary fixed wings may be as good as a screw-propelled one, and possess a powerful air brake, not so easily provided for alighting with a screw. But the engine which would suffice to carry a load of,

say, 2,000lbs. with a paddle propeller and fixed wings would be quite unable to lift 2,000lbs. directly off the ground, by setting the eccentric for vertical lift. The velocity of advance must bear a less ratio to the tangential one than the eccentricity OE does to the radius, because if that ratio be exceeded, the wheel will act as a brake on the forward velocity, until the engine speeds up to over that limit.

Reciprocating Feathering Paddles.

There remains an oar-like method of support, or propulsion, or both, in which a blade or wing is used in a way sometimes employed in paddling a Canadian canoe, when the paddle is never lifted clear out of the water, as an oar is, but is brought forward by a sweeping action edgewise after each back stroke, and, as with an oar, a succession of more or less isolated swirls or blocks of disturbance form the wake. The impulses here depend mainly on the acceleration of the paddle or oar during the back stroke, rather than its actual velocity. The matter is treated in a paper by the present writer, communicated by Lord Rayleigh to the Royal Society and published in the "Proceedings" A, Vol. 83, pp. 72-78, in 1909. Experimental data are not available and not easily procurable; but so far as theory goes, this way should be just as economical as any other, if not more so. Frequency of flapping here promotes economy of power, and the limits set to this are those imposed by the mechanical difficulties in guiding the acting blade so that it shall escape from, without obstructing, the successive swirls itself creates, in other words, shall avoid "catching crabs." It seems probable that the sensitiveness and power of quick adjustment acquirable by practice in muscular actions, would be capable of enabling birds and insects to use this method for hovering, and would account for the quick flapping which is always associated with this performance, in still air.*

The Helicopter.

A helicopter, with a pair of screws of about the proportions, as to blades, of the wings of a biplane, and of a diameter somewhat greater than its span, should obviously be able to carry the same load as the aeroplane if its screws revolved at such a rate that their wing tips travelled at about the same speed as the aeroplane does in the ordinary way. The revolutions, with diameter of about 30 feet, would be in the neighbourhood of 60 per minute, so that the engine would require reducing gear for a ratio of 20 or 30 to one, and the power transmission gear becomes a difficulty. Such a machine could perhaps be made to rise. If the whole were tilted, so that the originally vertical screw axles were inclined, it would travel horizontally, but if any considerable speed of advance were reached, strong vibratory bending stresses would occur in the screw shafts and the framing of their bearings, owing to unsymmetrical distribution of pressure on opposite screw blades when they were, in their revolution, continually changing their direction from across the relative wind to along it.

Fairholme, Monkstown, Co. Dublin, Sept. 2, 1914.

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* When time permits there is a large amount of experimental work requiring to be done on the subject of hovering flight. We had planned to undertake some of this long ago, but opportunity has been lacking. Meantime, the exact proportion in which "gliding" and "flapping" actions enter into the flight of birds and insects is quite undetermined experimentally.—EDITOR.

ON THE FLIGHT OF ALBATROSSES AND GANNETS.

BY DR. E. H. HANKIN, M.A., A.F.AË.S., F.R.MET.SOC., AGRA, INDIA.

I owe the greater part of the following information about the flight of the albatross to Captain E. H. Gordon, of the P. and O. ss. Company. He has studied these birds during numerous voyages, both on steamers and sailing ships. He has seen them near Cape Horn, the Cape, off the south coast of Australia, and at many other places.

The Albatross cannot soar in a calm.

Captain Gordon says that the flight of the albatross is by continuous gliding only in the presence of wind. If the wind is light occasional flaps are seen, and in complete calm only flapping is observed. This gliding flight occurs anywhere near sea level and is not restricted to an area near the leeward side of the stern of the ship as is usually the case with gulls.

In "Animal Flight"* I have detailed some observations that tend to show that the "soarable area" for gulls near the stern of the ship only exists in the presence of wind. In a calm gulls near the stern of a ship indulge in continuous flapping flight. Hence, the gliding flight of the albatross near sea level and the gliding flight of gulls in the "soarable area" are both cases of "wind soarability." Both with gulls and albatrosses the presence or absence of sunshine has no known effect on their flight near sea level, a further proof that we are dealing with "wind soarability" and not with "sun soarability."

The fact that the albatross is unable to indulge in soaring flight in the absence of wind has some theoretical interest. In the first place it may be noted that Captain Gordon's statement on this point is backed up by the experience of many other observers. Moseley† says that in perfectly calm weather they flap heavily. Another observer says that in a calm they are reduced to clumsy flapping. Another observer says that if the wind drops they at once come to rest on the water.

Soaring of Albatrosses not due to undiscovered wing-movements.

If the soaring flight of the albatross is due to undiscovered wing movements why is it that it cannot occur in the absence of wind? No reason can possibly be adduced why such movements could not be carried out in a calm. In the case of inland birds, on occasions of "sun soarability," I have pointed out that their soaring flight cannot be due to undiscovered wing movements, because the mode and speed of their flight varies with the amount of sunshine. If the sun is obscured by a gradually increasing layer of cloud, then, as the sunshine and glare decreases, there is a gradual decrease in the speed of the soaring bird and at last it is reduced to flapping flight. Similarly the soaring flight of certain species of dragonfly cannot be due to undiscovered wing movements, in view of the fact that such flight may be stopped or hindered by the presence of wind in some cases or in other cases by the presence of amounts of thin cirrus cloud, far too small to have any known effect on the flight of birds (see "Animal Flight," p. 363).

* London, 1914: Iliffe and Sons.

† "Notes by a Naturalist on the Challenger," pp. 134 and 570.

Thus, the proof that the soaring flight of the albatross is not due to undiscovered wing movements does not stand alone. It is supported by similar conclusions that can be drawn from a study of the soaring flight of other kinds of soaring creatures.

Albatrosses always start from the water in an upwind direction. While so doing they flap energetically, the head bobbing up and down between the strokes while the bird beats the water with its large webbed feet. But when once afloat in the air all appearance of exertion ceases.

Soaring is invariably connected with circling.

An interesting point about their flight is that they never gain height while on a level keel and travelling in a straight line. They only fly in a straight line for short distances and usually only when losing height preparatory to settling. Gain of height only occurs while the bird is on a curved course. When near a ship they are nearly always on a curved course and appear to be almost continually losing or gaining height.

Sometimes they leave the ship to descend on to food that has been thrown overboard; then perhaps a quarter of an hour later they rise into the air and by gliding flight easily and rapidly overtake the ship. While so doing their flight is constantly by circling. When near sea level, at all events, they never travel as the crow flies.

Though they frequently remain gliding for some time near the stern they occasionally travel away on a circular course, which may be a mile in diameter. While describing this course they are constantly circling with gain or loss of height.

The fact that their flight is not restricted to an area near the stern is a proof that the source of the energy is not some local eddy caused by the movement of the ship.

The fact that they still keep to circling when at a distance is a proof that circling is not merely indulged in in order to cut down their rate of progress to make it equal to that of the ship. Gannets and mollyhawks resemble albatrosses in their mode of flight. They are usually, when soaring, in a canted-over (banked) position and on a curved course, though so far as I am aware they have no habit of accompanying ships. Their preference for the canted-over position must have some other reason. I have elsewhere shown that circling, in the case of inland birds, is the mode of soaring flight that demands least energy from the air. In circling, too, banking is most when the bird is gaining most height (on the windward side of the track) and when its speed is least. Apparently when the bird is canted-over it is, for some unknown reason, in the best position for getting energy from the air for soaring flight. Perhaps this is the reason why banking is so much indulged in by soaring birds near sea level. If ascending currents were the source of the energy of soarability one would expect the bird to soar most easily while on a level keel.

Sometimes albatrosses circle round the ship. I have been told of a case in which an albatross was seen circling at a constant mean distance on the leeward side of the ship. It repeatedly described regular circles. These were in such a direction that the bird travelled astern when on the side of its circle nearest the ship. The smoke trail from the funnel was blowing out abeam and each time the bird passed through this smoke it showed a sudden movement which, from the description given me, appears to have been an oscillation round its longitudinal axis.

Albatrosses are only seen on the high seas and rarely come within 50 miles of land. When accompanying a P. and O. steamer along the south coast of

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Australia they always stay behind when the ship passes Kangaroo Island to go up the Gulf of St. Vincent to Adelaide. They rejoin the ship when it comes out of the gulf 24 hours later. The group of birds can be identified by their number being the same (it may amount to 40 or 50 birds) and it also often happens that one or more individuals have a feather missing or some other distinguishing mark by which they can be recognised.

The flight speed of Albatrosses.

Their usual speed through the air in a light wind is estimated by Captain Gordon as being about 45 miles an hour. It is impossible to see how currents reflected up from waves, say, of six inches height could maintain this speed at a height which may amount to 100 feet above the water. In fact I know of no one who has observed albatrosses who regards the ascending currents reflected up from waves as a probable source of the energy of their flight.

If the ship is travelling against a gale of wind the albatrosses still circle in its neighbourhood. Captain Gordon has never seen any sign of albatrosses being blown astern in a strong wind. It is therefore highly probable that their speed through the air is greater in a storm than it is in a light or fine weather wind.

This occurs in the case of soaring birds inland when in stormy winds. The cheel, for instance, glides ahead at greater speed through the air during a gust than during a lull. During a gust the speed of the bird through the air is generally at least greater than the speed of the air relatively to the earth. This is a fact of observation easily seen. In other words, a gust is a form of air movement that blows a feather to *leeward* at the speed of the wind, but that blows the complete bird (if it be a soaring bird) to *windward* at a speed greater than that of the wind (see "Animal Flight," p. 299).*

The vertical range of gliding of the Albatross.

When accompanying a ship the height at which the albatross glides, according to Captain Gordon, is anything between just over water level and a hundred feet above it. J. A. Froude (quoted in "Animal Flight," p. 259) says, "The flight is generally near the water, often close to it. You lose sight of the bird as he disappears in the hollow between the waves, and catch him again as he rises over the crest." This soaring flight near water level is a matter of some interest.

The interaction of waves and wind as creating vertical currents.

Generally in a strong wind the air moves ahead at a speed greater than that of the waves. Supposing the wind is dropping in the presence of large waves a point will be reached at which the speed of the air ahead is equal to that of the waves. In this case the mass of the air must be rising and falling with the movement of the water. Air on the advancing side of a wave must be rising. Air on the receding side of a wave must be descending.

In such a case an albatross gliding near water level on the advancing side of a wave must be virtually gliding in an ascending current of air. But in the

* Cheels, in my experience, never allow themselves to be blown to leeward by a wind. In highly soarable winds, as those of a dust storm, they can glide up wind, forging ahead relatively to the earth. On one occasion at Jharna Nullah, I noticed that as the wind increased cheels showed signs of being carried tail first to leeward. All the cheels that were up thereupon came down by carpal descent and settled. This was not a wind connected with a storm.

more usual case the speed of the wind is greater than that of the waves, and it becomes difficult to realise the exact nature of the air movement near water level.

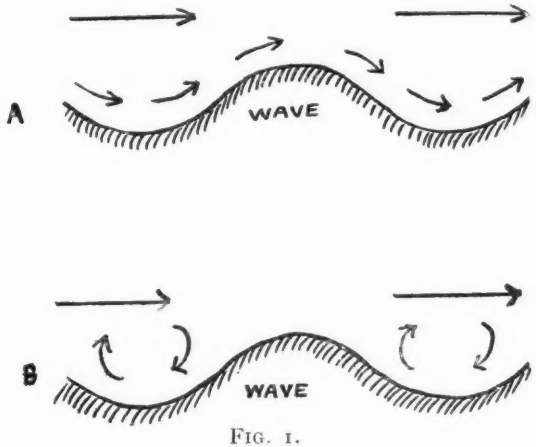

FIG. 1.

We may suppose that either the wind follows the water surface as at A, Fig. 1, or that it forms recurved eddies as B, Fig. 1. But in my experience ripples and wavelets appear as if the wind exerted, if not a regular pull, at all events a pull everywhere in a direction more or less identical with that of the wind. Perhaps the air near the water surface is always, or nearly always, moving ahead in the direction of the wind, but at very varying speeds. Should this be the case it might happen that recurved eddies are formed, and one would expect this more especially to occur when the speed of the wind is great relatively to that of the waves. Thus, in the absence of any direct evidence of what happens, there is room for a suspicion that albatrosses may have to soar (if they do soar on such occasions) in a descending current of air when they are near the advancing side of a wave. That birds can soar on the advancing side of a wave is indicated by the following observations:—

13th September, 1914, 11.0 a.m. Left Aden for Bombay.

14th September, 8.30 a.m. The ship was jumping about unpleasantly owing to rollers that came through the gap between Sokotra and the mainland. Wind west. Waves occasionally showing small white crests. A gannet skimming over the waves near the water surface was gliding almost continually. Gannets and boobies at heights of 5 to 15 metres above a flock of porpoises were in continued flapping flight.

8.50. Several gannets skimming near. One glided along the advancing side of a roller, but showed occasional flapping when descending on its up wind or receding side.

9.20. A gannet skimming. It flapped as soon as it got to the crest of a wave.

9.37. Gannets and boobies were in gliding flight as long as they remained on the advancing sides of waves. But along wave crests they were repeatedly seen to flap. Occasionally they also flapped when in the trough between two waves. They always glided when in the probably descending current on the advancing side of a wave.

During this time the wind was nearly astern and the smoke trail from the funnel was going ahead, as the speed of the wind was greater than that of the

ship. The fact that the waves occasionally had white crests perhaps indicates that the wind was travelling faster than the waves. Whatever may have been the nature of the air movement on the advancing side of the waves, air probably had an upward trend near the wave crests, *i.e.*, in the place where most flapping occurred. The possibility that soaring flight occurred in this case in a descending current on the advancing sides of the waves should not be negatived on any *a priori* grounds as I have other evidence relating to soaring flight in a descending current which I hope to bring forward on another occasion.

The circling of Gannets.

The flight of the gannet appears to resemble that of the albatross. The gannets were almost constantly on a curved course, generally strongly banked and often with one wing only just missing the water. That wind was of importance for this soaring flight is indicated by the succeeding observations:—

10.0. Wind less and less than speed of the ship as a head wind could now be felt. All birds in continuous flapping flight.

10.20. Surface nearly glassy, but faint ripples coming from aft direction.

Thus, as soon as the wind died away birds were reduced to flapping. But as soon as the wind rose again soaring flight again occurred:—

10.53. Surface now covered with large wavelets. A flying fish made a long flight, in the middle of which it momentarily flapped.

11.15. Birds now in gliding flight. Often after gliding on the advancing side of a roller they would shoot up to some height above its crest. (This gave me the impression that they were lifted by the rising current of air that met them at the crest of the wave.) Sharp wavelets, but no sign of creasing of the water surface. (In my notes I have given the name "creasing" to minute ripples, much smaller than ordinary ripples, and only seen in winds above a certain strength.)

12.10. Rollers now coming from S.S.E. Occasional squalls from this direction making sharp isolated wavelets. Wind between these squalls from west. Sea sick.

These observations indicate that when there was a further increase in the strength of the wind soaring flight occurred both on the advancing and on the receding sides of the waves. During the following two days there was a further increase of wind (it amounted to "moderate monsoon") and my diary contains on each day a reference to gannets being seen in soaring flight. On the 16th September I noted that gannets were in continuous soaring flight and showing frequent sudden gains of height. But I made no detailed observations of these birds as my attention was occupied by flying fishes. If my interpretation of the facts is correct, the air during these days had a high degree of soarability, judging from the behaviour of flying fishes. I hope to publish an account of these observations in a later issue of this journal.

The possibility of high non-circling gliding by Albatrosses.

The above description of the flight of albatrosses refers to their flight near sea level, in which flight they are practically always banked and on a curved course. But it is probable that, like gulls, they can flex-glide when at some height above sea level, that is, they can glide horizontally at high speed in a straight line and on a level keel. My reasons for believing in this, as yet unobserved, form of flight are as follows:—Large numbers of albatrosses are stated to collect on the body of a dead whale, especially during the breeding season. They are supposed to bring back pieces of this carrion to feed the brooding female who is on her nest perhaps many hundred miles away. It has been supposed

that they can discover a dead whale from some such distance as a hundred miles. At Tristan da Cunha albatrosses form their nests at a height of 7,000 feet above sea level, a height most probably reached by soaring flight ("Animal Flight," p. 260). In an old description of a voyage on a sailing ship the albatross is referred to as "that harbinger of storms," as though they flew elsewhere than near sea level in fine weather. The fact that no one has ever yet observed high level flight of the albatross is no proof whatever that it does not occur. For instance, it appears to be commonly believed that soaring flight is a phenomenon peculiar to tropical climates. As a matter of fact, anyone who will venture on a shilling excursion steamer on the south coast of England may easily see gulls performing, in most winds, in the soarable area at the stern, and if he takes the trouble to look upwards may, under certain weather conditions, see circling and flex-gliding of gulls at a height of a few hundred metres above sea level. This may be seen, in sunshine at least, in light off-shore winds when there is no possibility of the birds taking advantage of any known ascending current reflected up from the side of a cliff.

There are reasons for suspecting that the adjustments used for steering or banking in birds adapted for soaring flight at sea are different from the adjustments used by soaring birds inland. The matter is one that requires further investigation. The albatross, according to Captain Gordon's description, may descend by "carpal descent," but never by diving as does the vulture. A correspondent who has sent me a description of the flight of the gannet tells me that it occasionally dives into the water head first with outstretched wings, and suggests that this is a special case of soaring flight, the air energy involved in soarability being used to increase its downward speed. I have described such downward soaring in the case of vultures in "Animal Flight," p. 357.

Measuring the flight-speed of the Albatross.

It would be of interest to take measurements of the flight-speed of the albatross. This might be done by the following method.

Supposing a ship is travelling through the water at, say, 10 miles an hour against a head wind also of 10 miles an hour. The ship, we will suppose, is travelling in a straight line. Therefore the speed of the ship through the air must be 20 miles an hour. An albatross is circling near the ship and keeps up with it, though it is not travelling in a straight line, but in circles. From this it might appear that the speed of the bird through the air must be at least 60 miles an hour.

This inference is fallacious for the following reasons.

Let us consider the case in which the wind is astern and equal to the speed of the ship so that the smoke from the funnel ascends vertically.

In this case there is no difficulty in seeing that the speed of the albatross through the air has no necessary relation to that of the ship through the water. The albatross may be travelling at 10 metres per second, or at 100 metres per second, and still keep at a constant mean distance from the ship.

As observed from the ship the albatross will be found to spend exactly as much time going ahead as it does going astern, assuming its speed is constant.

Supposing now the wind changes round and becomes a head wind, then, obviously, if the albatross still spends as much time going ahead as it does going astern it must be left behind, whether its speed is 10 or 100 metres per second. In order to keep up with the ship it must spend more time going ahead and less

time going astern. That is to say, it must change the shape of its track from A to B (Fig. 2).

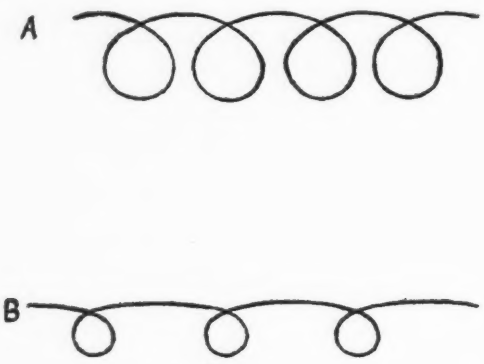

FIG. 2.

If the speed of the bird decreases then the loops on track B must become smaller and then must become infinitely small, *i.e.*, the track must be a straight line, if the speed of the bird decreases till it is equal to the speed of the ship through the air. Conversely, the greater the speed of the bird the more its track will approximate to A and differ from B.

In order to carry out the proposed measurement it is first necessary to know the speed of the ship through the water. This will be learnt by asking. It will be convenient to have this speed in metres per second. A speed of one nautical mile per hour is equal to a speed of .514 metres per second. Hence, if the speed of the ship is 16 knots it is going through the water at the rate of 8.22 metres per second. As a rough approximation it may be said that the speed of the ship in knots is equal to half as many metres per second.

The direction of the real wind is that of a line running at right angles to the crests of the waves (not of the swell if any swell is present). With a protractor measure the angle that this real wind makes with the long axis of the ship. This is represented in the accompanying figure (Fig. 3) by the line A B.

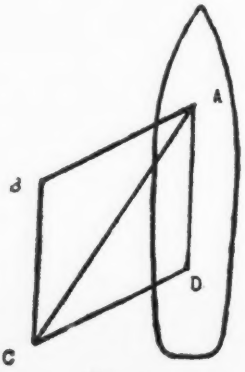

FIG. 3.

Also measure the angle made by the trail of smoke from the funnel with the long axis of the ship. This is represented by C D. This is the direction of the apparent wind. Draw the line A D of any convenient length in the direction of the long axis of the ship. Complete the parallelogram A B C D. Divide A D into a number of equal parts equal to the number of metres per second that the ship is moving through the water. Measure how many of these parts go into A B. This gives the velocity of the real wind. A similar measurement of A C gives the velocity of the apparent wind.*

Two observers standing, one at E′ and the other at F′ (points at a known

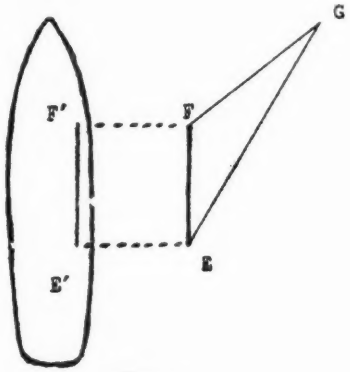

FIG. 4.

distance from one another on the ship), can observe the time taken by an albatross in gliding from E opposite E′ to F opposite F′. The distance E F is known. The time at which it covers this distance is known. The speed at which it travels this distance relatively to the ship can therefore be calculated. This speed added to the speed ahead of the ship is equal to the speed ahead of the albatross over the water. But what we want to measure is the speed ahead of the albatross relatively to the air, or in other words its apparent wind. Divide E F into a number of equal parts equal to the number of metres per second that the bird is gliding ahead relatively to the water. On the same scale draw F G in the direction of and in length representing the real wind. Join E G. Then the line E G in its direction represents the apparent wind relatively to the albatross and the length of E G represents the speed of this apparent wind, in other words, the speed of the bird through the air. It may be noted that this method would only be applicable in cases in which it is possible to observe the bird travelling for a sufficient distance in a direction parallel to the long axis of the ship.

* Since writing this paper I have been informed that an almost identical method of working out the wind velocity at sea has been used by A. L. Rotch, of the Blue Hill Observatory. An instrument for making the necessary measurements is made by Casella, 147, Holborn Bars, London, E.C.

THE ROYAL FLYING CORPS ON ACTIVE SERVICE.

Further evidence of the extremely important part played by aircraft in the conduct of the war is afforded in the official announcements that are here placed on record.

It is a long, long way to the time when we shall be free to discuss fully their achievements and the lessons to be learnt therefrom, but it is certain that, when the history of their rôle comes to be written, aircraft will be found to have exercised a decisive effect on the issue of the conflict.

From Sir John French's Despatch, November 20th, 1914:—

"The work performed by the Royal Flying Corps has continued to prove of the utmost value to the success of the operations. I do not consider it advisable in this despatch to go into any detail as regards the duties assigned to the Corps and the nature of their work, but almost every day new methods for employing them, both strategically and tactically, are discovered and put into practice. The development of their use and employment has indeed been quite extraordinary, and I feel sure that no effort should be spared to increase their numbers and perfect their equipment and efficiency."

Admiralty Report, 27th December, 1914:—

"On Thursday last, Squadron Commander Richard B. Davies, R.N., of the Naval Air Service, visited Brussels in a Maurice Farman biplane for the purpose of dropping twelve bombs on an airship shed reported to contain a German Parseval. Eight of these bombs, of which six are believed to have hit, were discharged at the first attack and the remaining four on the return flight. Owing to the clouds of smoke which arose from the shed the effect could not be distinguished."

"On Friday (Christmas Day) German warships lying in Schillig Roads, off Cuxhaven, were attacked by seven naval seaplanes, piloted by the following officers:—

"Flight Commander Douglas A. Oliver, R.N.
"Flight Commander Francis E. T. Hewlett, R.N.
"Flight Commander Robert P. Ross, R.N.
"Flight Commander Cecil F. Kilner, R.N.
"Flight Lieutenant Arnold J. Miley, R.N.
"Flight Lieutenant Charles H. K. Edmonds, R.N.
"Flight Sub-Lieutenant Vivian Gaskell Blackburn, R.N.

"The attack was delivered at daylight, starting from a point in the vicinity of Heligoland. The seaplanes were escorted by a light cruiser and destroyer force, together with submarines. As soon as these ships were seen by the Germans from Heligoland, two Zeppelins, three or four hostile seaplanes, and several hostile submarines attacked them.

"It was necessary for the British ships to remain in the neighbourhood in order to pick up the returning airmen; and a novel combat ensued between the most modern cruisers on the one hand and the enemy's aircraft and submarines on the other. By swift manœuvring the enemy's submarines were avoided, and the two Zeppelins were easily put to flight by the guns of the 'Undaunted' and 'Arethusa.' The enemy's seaplanes succeeded in dropping their bombs near to our ships, though without hitting any. The British ships remained for three hours off the enemy's coast without being molested by any surface vessel, and safely re-embarked three out of the seven airmen with their machines.

"Three other pilots who returned later were picked up, according to arrangement, by British submarines, which were standing by, their machines being sunk. Six out of the seven pilots, therefore, returned safely. Flight Commander Francis E. T. Hewlett, R.N., is, however, missing. His machine was seen in a wrecked condition about eight miles from Heligoland, and the fate of this daring and skilful pilot is at present unknown. The extent of the damage by the British airmen's bombs cannot be estimated, but all were discharged on points of military significance."

(Flight Commander Hewlett was rescued by a Dutch trawler and subsequently returned safely to England.)

Memorandum from the Director of the Admiralty Air Department, published on January 1st, 1915:—

December 17th, 1914.

"On November 21st, 1914, Squadron Commander E. F. Briggs, Flight Commander J. T. Babington, and Flight Lieutenant S. V. Sippe, Royal Navy, carried out an aerial attack on the Zeppelin airship sheds and factory at Friedrichshafen on Lake Constance.

"Leaving French territory shortly before 10 a.m., they arrived over their objective at about noon, and, although under a very heavy rifle, machine-gun, and shrapnel fire from the moment they were sighted, they all three dived steeply to within a few hundred feet of the sheds, when they released their bombs—in all eleven.

"Squadron Commander Briggs was wounded, brought down, and made a prisoner, but the other two officers regained their starting point after a flight of more than four hours across hostile country under very bad weather conditions.

"It is believed that the damage caused by this attack includes the destruction of one airship and serious damage to the larger shed, and also the demolition of the hydrogen-producing plant, which had only lately been completed. Later reports stated that flames of considerable magnitude were seen issuing from the factory immediately after the raid."

Admiralty Report, 23rd January, 1915:—

"On Friday, the 22nd, 12 or 13 German aeroplanes appeared over Dunkirk at 11.30 a.m. and dropped bombs. No particular damage was done, except that a shed in the docks was set on fire. One of the bombs fell just outside the United States Consulate, breaking all the windows and smashing the furniture.

"Belgian, French and British naval and military airmen engaged the German aeroplanes, one of which was brought down by a British military machine just over the Belgian frontier. The German aeroplane, pilot, and passenger were captured.

"During the day visits were paid to Zeebrugge by Squadron Commander Richard B. Davies and Flight Lieutenant Richard Peirse. Twenty-seven bombs were dropped on two submarines and on the guns on the mole. It is believed that one submarine was damaged considerably, and that many casualties were caused amongst the guns' crews.

"In making a reconnoitring flight before this attack Squadron Commander Davies was on one occasion surrounded by seven German aeroplanes, but managed to elude them. He was slightly wounded in the thigh on his way to Zeebrugge, but continued his flight, accomplished his mission, and is now progressing satisfactorily."

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THE ROYAL FLYING CORPS.

REORGANISATION OF MILITARY WING.

Some indication of the expansion of the Military Wing of the Royal Flying Corps, rendered necessary, firstly by its extended duties, and secondly by the hugeness of the Armies with which it will be associated in the immediate future, is afforded by the following announcement of the reorganisation of the Wing.

An Army Order, issued on 18th January, 1915, details the reorganisation of the Military Wing of the Royal Flying Corps. The Corps will be formed into wings, each with its commanding officer, and the post of O.C. Royal Flying Corps is abolished. Lieutenant-Colonel F. H. Sykes, 15th Hussars, held the latter appointment, and was recently re-gazetted as a General Staff Officer of the First Grade. The Army Order sets out the following points:—

The Royal Flying Corps (Military Wing) will be organised in wings, each under a separate commanding officer and consisting of two, three, or, in special cases, four squadrons.

An additional Wing Commander, designated the Administrative Wing Commander, will command the Royal Flying Corps depot, and be the officer in charge of Royal Flying Corps records. In war he will also command the Reserve Aeroplane Squadrons and the Aircraft Park at home.

The appointment of Officer Commanding the Royal Flying Corps (Military Wing) is abolished.

Provisional establishments for flying headquarters, for the headquarters of the Administrative Wing, and for the Royal Flying Corps depot are issued.

Wing Commanders will be responsible for the training and administration of their wings, including accounting for equipment, clothing, and necessaries.

The Adjutant will assist the Wing Commander in all questions of training and discipline.

The Equipment Officer will assist the Wing Commander in all questions concerning technical stores; he will account for all technical stores on charge of the wing, making such issues to Squadron Commanders as may be necessary to maintain the equipment of their squadrons. He will obtain receipts from Squadron Commanders for all issues, and will grant receipts for all stores returned, but there will be no ledger transactions between Squadron Commanders and Equipment Officers.

The Administrative Wing Commander will carry out similar duties as regards the Reserve Aeroplane Squadrons, the Royal Flying Corps Depot, and the Aircraft Park; he will also be responsible for the final approval of all recruits, and for the recruiting of men specially enlisted during war; for the allotment of *personnel* to squadrons, for the despatch of reinforcements of *personnel* abroad, and for preparing the monthly statement of allowances and extra pay of all the officers of the Royal Flying Corps.

Personnel will on enlistment be sent to the Royal Flying Corps Depot for training. Here they will be trained not only in the ordinary duties of a soldier, but also in their technical duties as air-mechanics in the technical section of the Royal Flying Corps Depot. From the depot they will be drafted to wings

according to requirements. Training at the depot will normally take six months, but will often be much curtailed during war.

Promotion to the rank of sergeant will be made by Wing Commanders; promotions above the rank of sergeant will be based on the recommendations of Wing Commanders and authorised by the Officer in Charge of Records from a general roll of non-commissioned officers kept by him.

The establishments will be as follows:—

	Officers.	Sergts.	Corpls.	Air Mechanics and Privates.	Total.
Wing Headquarters ...	3	6	3	18	30
Administrative Wing ...	4	3	11 rank and file		18
Records and Recruiting	2	7 civilians	—	—	9
Depot	7	10*	228 rank and file		246

* And 1 Warrant Officer.

LIST OF BRITISH FATALITIES.

Date. 1914.	Name.	Nationality.	Machine.	Place.
Sept. 29	Lieut. H. D. Vernon, R.N. Lieut. B. D. Ash, R.N. (P)	English.	Short Seaplane (2).	North Sea (lost).
Oct. 26	Captain Th. Crean Lieut. C. G. Hosking	English.	B.E. 2 (2).	In Flanders.
Nov. 1	R. J. Alston (P)	English.	Sopwith Seaplane (2).	Southampton Water.
,, 5	Sub-Lieut. P. B. Murray, R.N.	English.	B.E. 2 (2).	Upavon.
,, 5	Lieut. F. Beevor, R.N. Earl Annesley (P)	English.	Sopwith (2).	Dixmude.
,, 5	E. T. Busk	English.	B.E. 2 (2).	Farnborough.
,, 24	Lieut. H. R. Fleming	English.	B.E. 2 (2).	Upavon.
Dec. 5	Sub-Lieut. B. O. Ffield	English.	M. Farman (2)	Hendon.
,, 20	Captain Picton-Warlow	English.	Bleriot (1)	Lost at sea.
1915.				
Jan. 2	Captain W. Lawrence	English.	Bleriot (1)	France.
,, 18	Captain E. F. Chinnery (P)	English.	Voisin (2)	Paris.
,, 19	2nd-Lieut. M. L. Gardner	English.	M. Farman (2)	S. Farnborough.
,, 19	Captain H. J. A. Roche	English.	B.E. 2 b. (2)	nr. Dunkirk.
,, 20	Major G. H. Raleigh	English.	Sopwith (2)	nr. Dunkirk.

(1) Monoplane. (2) Biplane. (P) Passenger.

NEW BOOKS AND PUBLICATIONS.

*Aircraft in the German War. H. Massac Buist. London: Methuen and Co. 1914. pp. 128. Illus. Price 1s.

*Aircraft in War. E. Stuart Bruce. London: Hodder and Stoughton. 1914. pp. 177. Illus. Price 1s.

*Stability and Equilibrium of Floating Bodies. B. C. Laws, B.Sc. London: Constable and Co. 1914. pp. 251. Figs. Price 10s. 6d.

*The Mastery of the Air. W. J. Claxton. London: Blackie and Sons. 1914. pp. 258. Illus. Price 2s. 6d.

*Modern Weapons of War, by Land, Sea and Air. Cyril Hall. London: Blackie and Son. 1915. pp. 192. Illus. Price 2s. 6d.

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*Books on the Great War. F. W. T. Lange and W. T. Berry. London: Grafton and Co. 1915. pp. 55. Price 2s. 6d. net.

* See Review in present issue.

REVIEWS.

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Aircraft in War. Eric Stuart Bruce. (London: Hodder and Stoughton. 1914. pp. 77. Illus. Price 1s. net.)

Aircraft in the German War. H. Massac Buist. (London: Methuen and Co., Ltd. 1914. pp. 128. Illus. Price 1s. net.)

The Mastery of the Air. W. J. Claxton. (London: Blackie and Son. 1914. pp. 258. Illus. Price 2s. 6d.)

Modern Weapons of War, by Land, Sea and Air. Cyril Hall. (London: Blackie and Son. 1915. pp. 192. Illus. Price 2s. 6d.)

"The Times" History of the War. Vol. II., Part 18. "Military Aeronautics and the British Air Service." pp. 173-196. Illus. (London: "The Times." 1914. Price 7d. net.)

"T.P.'s Journal," Great Deeds of the Great War. Edited by T. P. O'Connor. Vol. I., No. 8. pp. 199-202. Illus. Vol. I, No. 9. pp. 231-234. Illus. (London: "The Daily Telegraph." 1914. Price 3d. per number.)

It is convenient to consider these publications together, as they either owe their production to the fact that we are at war or gain an added appeal from that fact.

It is customary, we believe, to have in newspaper offices draft obituary notices of all persons of note, for use when the time comes, and generally the newspaper man endeavours to anticipate events, so that when an event occurs he will be ready with matter which only requires to be put to use. The unexpected (to the layman) success of aircraft in the present war has not however found an adequate store of aeronautical knowledge at the disposal of newspapers and

other periodicals. The result has been some lamentably inadequate productions, and speaking generally one may say that the aeronautical literature so far published during the war has been disappointing.

Books on the Great War.—This is a most useful work and if it is kept up-to-date, as is promised, can only gain in value. The present and future librarian and historian cannot fail to be grateful to Messrs. Lange and Berry, of the St. Bride Foundation Libraries, for seizing the opportunity of making a complete list of the contemporary literature of the present war. The section "Aeronautics" is complete, except that "Modern Weapons of War" and "Discoveries and Inventions of the Twentieth Century," both of which contain small sections devoted to aircraft, are not included.

Aircraft in War.—This little book is a reprint of articles which appeared originally in the "Daily Telegraph," and shows signs of hasty preparation. The author does not appear to have been in touch in every case with the latest details of the subject, so that we find, side by side with descriptions of events that occurred while the book was being written, references to aeronautical ideas that can only be described as archaic. Nevertheless, there is quite a lot of very useful information to the general public in the book, and some compliments to the Aeronautical Society.

Aircraft in the German War.—The subject matter of this book originally appeared in the "Morning Post," wherein, in fact, the aeronautical articles by Mr. Buist are familiar to all the aeronautical world. It is not necessary to review the book in detail, suffice to say that it fulfils its avowed object as "merely an introduction of the briefest and most deliberately untechnical sort, designed to give the reader a clear notion of the scale of the aerial establishments of the various countries concerned, of the chief points concerning which each equipment differs from another, and of the general principles of the use being made of aircraft in the German war." The value of the work is enhanced by the inclusion of three diagrams from "Flight," illustrating the technical terms recently published by this Society. A small error may be noted on page 105—"zanolia" instead of "zanonia."

The Mastery of the Air.—"This book makes no pretence of going minutely into the technical and scientific sides of human flight; rather does it deal mainly with the real achievements of pioneers who have helped to make aviation what it is to-day." The above quotation from the preface shows what the author has attempted, and it must be said that considering the size of the book, quite a lot has been squeezed into it. It naturally invites comparison with previous works, often to its disadvantage, but the member of the general public who has read it may be said to have had a fairly reliable introduction to the subject. The following errors should, however, be corrected as soon as possible. Facing page 16 is a plate entitled "Pioneers of *Aviation*." This should be "Pioneers of *Aeronautics*," as it includes the Montgolfiers, Pilate de Rosier (sic), Zeppelin, Lilienthal, and the Wright Brothers. On page 23 the Brothers Robert are called the Roberts Brothers. On page 35 Garnerin is rendered Gernerin. Facing page 80 is a plate of the Henson and Stringfellow Model, now at the Science Museum, shown upside down. On page 129 it is said that the Wright propellers in their early machines were driven at about 1,200 revolutions per minute. Actually, however, this was the speed of the engine, which was coupled to the propellers through a gearing of about 3 to 1. It would be interesting to know whence Mr. Claxton obtained the surprising information (page 142) that the Antoinette mono-

plane was evolved by Bleriot in conjunction with Lavavasseur (sic). Facing page 144 "libelliele" appears instead of "Libellule." On page 147 Mr. J. W. Dunne is referred to as a *naval* lieutenant. On page 242 a gliding angle of 1 in 12 is mentioned as being quite a usual thing in present-day machines.

One of the least praiseworthy sections is that devoted to technical terms. This is rather inadequate, and in many cases is in conflict with the authoritative list of terms issued by this Society. One's teeth are set on edge also by such aerodrome journalese as "volplaning" (instead of "gliding"), "vol plane" and "vol pique" appear as now printed, *i.e.*, without their terminal accent.

Modern Weapons of War, by Land, Sea and Air.—Doubtless to catch the public eye this book is issued in a loose cover on which is represented a French aeroplane equipped with a machine gun, and the frontispiece represents airships manœuvring over a sea fleet. Actually, however, ten pages out of 192 are devoted to aircraft. Needless to say, nothing more is done than to give a few fragmentary comments on the employment of aeroplanes in war.

"Times" History of the War.—Chapter XXXV., "Military Aeronautics and the British Air Service." Considering that the present publication is avowedly designed for "our children's children" it is extremely regrettable that so inadequate a treatment should be accorded to the subject of Chapter XXXV. Its 24 pages, of which much is taken up by illustrations, could not possibly be adequate for the subject, and although some useful information is imparted to the reader, "our children's children" will gain but a scrappy acquaintance with the subject from these pages. One would suppose from the manner in which archaic machines are illustrated that the compiler had in mind more the deceiving of our enemies regarding our aeronautical knowledge than the edification of posterity. The fact is, of course, that even supposing that this section of the history had been written by one adequately equipped with the necessary knowledge, the censor would rightly have prevented him, at the present moment, from imparting much of it to the public. At the same time, if this chapter had only included the information concerning our Flying Services that was common property before the outbreak of war, it would have been very much larger and more complete than the present production.

"T.P.'s Journal" of Great Deeds of the Great War.—Vol. I., No. 8, "The Individual Ascendancy of the British Airman." Vol. I., No. 9, "The Supremacy of the Air." It would be difficult to find anywhere at any time more mis-information for the general public concerning aircraft in war than is contained in the six pages which comprise the above two articles. It is impossible in a short notice to do justice to the unconscious humour with which these pages abound, but one can imagine the roar of laughter with which the R.N.A.S. would read on page 202 of "A man like Lieut. Collet, a true British type, a man who would rather walk from London to Hendon than ride in an automobile. . . . Lieut. Collet can not only shape a course by compass, but he can shape one without it. . . . He could find his way without map from Hendon to Constantinople, if he were called upon to do so. . . ."

The general trend of the articles is that the German aviator has a far superior machine to the Britisher, but is beaten by the latter because of the latter's sporting temperament. We read this summing-up: "With all these conditions in favour of the German flier, it is a wonder that the Britisher on his 'box-kite' of wood and piano-wire, and on his haphazard seat of canvas slung between two wooden supports, can meet and drive the individual German flier out of the air

at all. Still, as last week's article explained, he does it, and does it repeatedly. What British fliers would do if they were equipped as their foe can be imagined."

One more delightful piece of humour must be recorded. We are told that in German aeroplanes for war "steel was used exclusively." A little lower down we read, "A young officer might come into the sheds at any moment to examine a half-finished machine. He would go over it inch by inch; if he detected a flaw, even a splash of glue at a joint, condemnation was as sure as an inexorable law of nature. It was not mere verbal expression of disapproval. The officer did not deign to that. He just reached out for a saw and cut the offending part of the machine to pieces." It would need the genius of George Morrow to convey to us an adequate picture of a workman gluing up steel framework or the officer sawing it up.

Stability and Equilibrium of Floating Bodies. Bernard C. Laws. (London: Constable and Co. 1914. pp. 251. Figs. Price 10s. 6d. net.)

"The present treatise is an attempt to set forth briefly the principles underlying the stability and equilibrium of bodies floating partially or wholly submerged in water, and in air." Besides the chapter, pages 214-235, devoted to aircraft, references of interest to the aeronautical student occur elsewhere, *e.g.*, in the introduction fluid pressure on a body in motion is dealt with, not however very adequately. Some rather misleading diagrams of laminæ moving in water and air are given on pages 5 and 8 respectively. Mr. Froude's experiments are referred to, but not those of Dr. Stanton, and this section does not appear to show very great familiarity with the subject matter. Incidentally, Lord Rayleigh is called Lord Raleigh, and Soldati appears as Soldate. The chapter on aircraft, consisting of 22 pages, is of course much too small adequately to deal with the subject. Bryan and his masterly system of analysis are not even mentioned, so it is obvious that this chapter will not be of much use to the aeronautical student. In treating of lateral stability it appears to have been assumed that the couple caused by the rotation of the keel plane about the centre of gravity of the machine is a righting couple. Its effect, however, is merely to damp a roll, not to restore the machine to an even keel. The sideslip necessary to accomplish this is not mentioned.

Discoveries and Inventions of the Twentieth Century. Edward Cressy. (London: George Routledge and Sons, Ltd. 1914. pp. 398. Illus. Price 7s. 6d. net.)

This is an ambitious book, much of which falls beyond the purview of these pages. One may express the opinion, however, that it would form an admirable present for any youth of an engineering turn of mind, and it could be read with profit by anyone wishing to gain a rapid idea of modern engineering progress, embracing such diverse accomplishments as steam turbines, pedigree wheat, motor cars, radium, moving staircases, to mention just a few of the subjects touched on. References of aeronautical interest are scattered throughout its pages. The Gnome Engine is briefly described on pages 66, 67, and there is a plate of it facing page 68. Autogenous welding is referred to, pages 133 and 134. Streamline photographs, in connection with ship design, are shown facing pages 264 and 265. Dr. Lucien Bull's photographs of insect flight are referred to on pages 366 et seq., while there is a chapter, pages 283-299, devoted to aircraft. This section is necessarily sketchy and not always accurate. Certain machines are illustrated as, for example, "The Vickers Monoplane," "The Farman Biplane." It is a pity that such illustrations do not indicate the date of the machine in question. Airships are treated quite inadequately in four pages, but a book of this nature cannot, of course, hope to be comprehensive in its details.

YUM

The Essays of an Aviator. (London: "Aeronautics." 1914. pp. 45. Price 2s. 6d.)

The six essays comprising the present book appeared originally in "Aeronautics," and many who read them in the pages of that periodical hoped that they might be collected together into some more permanent form. This hope is realised, and it is with difficulty that one refrains from wholesale quotation in order to show what a desirable acquisition the resulting forty-five page booklet is. One cannot, however, do justice by quotation to the gentle philosophy of these pages, one absorbs it by reading and re-reading them, missing however the final essay on war, with which crude actuality has dealt somewhat unkindly, while at the same time emphasising its concluding sentence: "Besides, war is a silly game, anyway."

Flight without Formulæ. Com. Duchêne. Translated from the French by John H. Ledeboer, B.A. (London: Longmans, Green and Co. 1914. pp. 211. Figs. Price 7s. 6d.)

The value of this work was noted in these pages (AERONAUTICAL JOURNAL, October, 1913, pp. 267-268) when it originally appeared in French, and it is a matter for congratulation that so excellent a translation should so soon have appeared in the English language. The book should be in the library of all aeronautical students.

The Aeroplane. C. Grahame-White and Harry Harper. (London: T. C. and E. C. Jack. 1914. pp. 280. Illus., 16 plates. Price 3s. 6d. net.)

"Our aim in these pages is to tell a complete story of the aerial conquest, beginning from crude experiments, made hundreds of years ago; passing thence to the first serious experimenters, with their difficulties and triumphs; and so carrying on the tale to present-day achievements and the latest-type machines."

The above quotation from the preface, coupled with the knowledge that this work belongs to a "Romance of Reality" series, enables one to appreciate the point of view that has given it birth, and bearing in mind this point of view one must congratulate the authors on an excellent achievement. Not that they tell the diligent student anything new, he can in fact point to omissions, but there is no doubt that the combining together of already known facts into a connected narrative with a strong personal and romantic appeal has been very successfully accomplished. The present writer cannot say what sort of a picture the novice would gather from a perusal of the book, but he can promise anyone who has grown up with the modern flying movement an enjoyable time gliding skilfully over the history of the events that he himself has seen and taken part in. It is doubtless due to the limitations of space that the early history is rather sketchily dealt with, and perhaps it is too much to expect that the problem of stability should have received more attention, for this would have required a third and perhaps a fourth collaborator. One may perhaps sum the matter up by saying that the book is written from the point of view of the pilot, as was indeed to be expected. Nevertheless, one may hope that ere long there will arise one who will give us a similar book from the point of view of the aeronautical laboratory. It would be an interesting complementary volume to the present. The least desirable portion of the book is that wherein the authors are rash enough to descend to details of the "air-liner" of twenty years hence, for here our laboratory expert will feel that they are rushing in where he fears to tread; certainly the frontispiece depicting "The Air-Liner of the Future" would cause him much mental anguish, which would be intensified by the picture on page 194 showing two air bombs dropping in a perfectly straight line, from an aeroplane, upon an airship.

Despite its title the book contains a section on airships, not very adequate.

XUM

All the World's Aircraft. By Fred. T. Jane. Sixth year of issue. (London: Sampson, Low, Marston and Co. 1914. pp. 202 + 19b + 14c + 19d. Illus. Price 21s. net.)

War is the supreme test of many theories and other products of peace-time; it serves to justify a few and condemn the majority. Such a compilation as the present, which has now attained its sixth year of issue, should have been pre-eminently useful—even if not especially designed for the purpose—as a serious reference book, enabling even the "man in the street," to whom all aircraft are still Zeppelins, to estimate at a glance the strength of the aerial navies of the world and, more important still, to recognise without undue difficulty the nationality of any particular type of machine. In order to achieve this purpose such a work must, first and foremost, be endowed with two qualities, which are largely complementary—it should be reliable and complete. It is to be regretted that neither Mr. Jane's work nor any other in the English language fulfils these essential requirements. Let it be admitted in fairness to the industrious author that the want of completeness is in many cases due to its premature publication owing to the sudden outbreak of the war; that the British section has suffered severely from the vagaries of the censor, who has blotted out entire pages of innocuous photographs.

Even so, its many faults are due primarily to the want of cohesion of the scheme upon which it was founded—a point that has more than once been referred to in regard to previous issues in these pages—to the introduction of much irrelevant matter, and, last but not least, to what can only be described as the frequent inaccuracy of such information as it contains. The pity of this lack of reliability is that, when once discovered in one particular instance, it leads one to doubt other points which may, in actual fact, be perfectly correct.

The spelling of foreign names, one of the glaring faults of previous issues, has been assiduously corrected, but even yet leaves much to be desired. The information relating to aviation in India and South Africa is absurdly scanty and ridiculously incomplete, and forms a complete travesty of facts which were public property (at all events in aviation circles) well over a year ago. Omissions, indeed, form one of the most serious blemishes of the work. Russia, for all its Sikorskys, would seem, to judge from these pages, to have no aeroplanes of native design, notwithstanding that photographs and drawings of many have appeared in the technical and even the lay Press. Though Farmans, and Italian built at that, form by far the greatest proportion of Italian military machines, the existence of their factory there is entirely ignored. No reference whatever is made to the British instructors to the Greek Navy, who have rendered such fine services under Mr. Collyns Pizey. The so-called description of the Schütte-Lanz would make its designer weep and does not even mention the salient fact that its skeleton is built of wood. Finally, with hundreds of modern photographs available, why only publish a single indifferent little print of a 1911 Avro, long since discarded?

The truth is that, for all Mr. Jane's courageous efforts, it is impossible at present to draw a strict analogy between aircraft and warships and to cast a work such as this now under review in the mould of his "Fighting Ships." Whether future developments will alter this view must, of course, remain an open question; but for the present, while we may admire Mr. Jane's courage and perseverance, we cannot but regard his work as failing in its object. Whatever the future may bring forth, let us once again impress upon Mr. Jane the cardinal virtues of accuracy and completeness.

J. H. L.

CORRESPONDENCE.

ATMOSPHERIC ROTARY MOVEMENTS OF SMALL EXTENT.

The Editor, THE AËRONAUTICAL JOURNAL.

DEAR SIR,—About twenty years ago I witnessed a phenomenon similar to a "dust devil" in a newly-cut hayfield in Sussex. It was a very sunny afternoon, and I saw two or three spirals, rising perhaps twenty feet.

Yours faithfully,

C. DENDY MARSHALL.